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Solid Waste

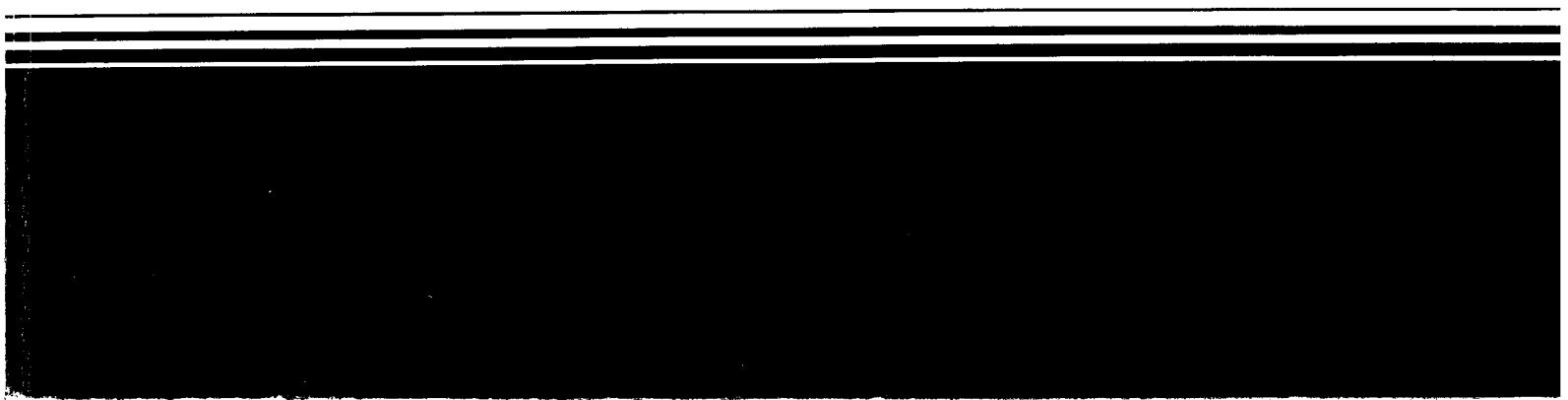
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# **Best Demonstrated Available Technology (BDAT) Background Document for K101, K102**

## **Proposed**

### **Volume 12**



PROPOSED  
BEST DEMONSTRATED AND AVAILABLE TECHNOLOGY (BDAT)  
BACKGROUND DOCUMENT  
FOR K101 AND K102

VOLUME 12  
(Veterinary Pharmaceutical Industry)

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## EXECUTIVE SUMMARY

### BDAT Treatment Standards for K101 and K102

Pursuant to the Hazardous and Solid Waste Amendments (HSWA) enacted on November 8, 1984, and in accordance with the procedures for establishing treatment standards under section 3004 (m) of the Resource Conservation and Recovery Act (RCRA), the Environmental Protection Agency (EPA) is proposing treatment standards for the listed wastes, K101 and K102, based on the performance of treatment technologies determined by the Agency to represent Best Demonstrated Available Technology (BDAT). This background document provides the detailed analyses that support this determination.

These BDAT treatment standards represent instantaneous maximum acceptable concentration levels for selected hazardous constituents in the wastes or residuals from treatment and/or recycling. These levels are established as a prerequisite for disposal of these wastes in units designated as land disposal units according to 40 CFR Part 268 (Code of Federal Regulations). Wastes which, as generated, contain the regulated constituents at concentrations which do not exceed the treatment standards are not restricted from land disposal units. The Agency has chosen to set levels for these wastes rather than designating the use of a specific treatment technology. The Agency believes that this

allows the generators of these wastes a greater degree of flexibility in selecting a technology or train of technologies that can achieve these standards. These standards become effective as of August 8, 1988, as described in the schedule set forth in 40 CFR 268.10.

According to 40 CFR 261.32 (hazardous wastes from specific sources) waste codes K101 and K102 are from the veterinary pharmaceutical industry and are listed as follows:

- K101: Distillation tar residues from the distillation of aniline-based compounds in the production of veterinary pharmaceuticals from arsenic or organo-arsenic compounds.
- K102: Residue from the use of activated carbon for decolorization in the production of veterinary pharmaceuticals from arsenic or organo-arsenic compounds.

Descriptions of the industry and specific processes generating these wastes, as well as descriptions of the physical and chemical waste characteristics, are provided in Section 2 of this document. The four digit Standard Industrial Classification (SIC) code most often reported for the industry generating this waste code is 2834 (veterinary pharmaceutical). The Agency estimates that there are two facilities that may potentially generate wastes identified as K101 and K102.

The Agency has determined that K101 and K102 collectively represent one general waste treatability group with two subgroups

- wastewaters and nonwastewaters. For the purpose of applicability, wastewaters are defined as wastes containing less than 1% (weight basis) filterable solids and less than 1% (weight basis) total organic carbon (TOC). Wastes not meeting this definition must comply with treatment standards for nonwastewaters.

These two treatability subgroups represent classes of wastes that have similar physical and chemical properties within the treatability group. EPA believes that each waste within these groups can be treated to the same concentrations when similar technologies are applied. The Agency has examined the sources of these two wastes from the veterinary pharmaceutical industry, the specific similarities in waste composition, potential applicable and demonstrated technologies, and attainable treatment performance. While the Agency has not, at this time, specifically identified additional wastes which would fall into this treatability group or two subgroups, this does not preclude the Agency from using these treatment performance data to establish standards for other similar wastes, in the future. A detailed discussion of applicable and demonstrated treatment technologies is provided in Section 3 of this document.

The K101 and K102 wastes, as generated, have a high total organic carbon and filterable solids content and are typically classified as organic nonwastewaters. The EPA has determined



that incineration represents BDAT for organics in this waste. Residues from treatment by incineration include ash and scrubber waters, both of which contain BDAT list metals. The scrubber waters are classified as K101/K102 wastewaters and are generated primarily as a result of the "derived from" rule and "mixture rule" as outlined in 40 CFR 261.3 (definition of hazardous waste). Chemical precipitation was determined to be BDAT for the metals present in the wastewaters. The residuals generated from chemical precipitation are an inorganic form of the K101 and K102 nonwastewaters. Kiln ash from incineration of K101 and K102 is also as an inorganic nonwastewater form of K101 and K102. Metals stabilization was determined to be BDAT for K101 and K102 inorganic forms of nonwastewaters. A discussion on the selection of best demonstrated applicable treatment (BDAT) technology is provided in Section 4 of this document.

#### Nonwastewaters

For nonwastewaters, one (1) organic constituent and nine (9) metal constituents are proposed for regulation in both K101 and K102. The one organic constituent in K101 being proposed is 2-nitroaniline.<sup>1</sup> The one organic constituent proposed for

- 
1. This constituent is not on the list of constituents in the GENERIC QUALITY ASSURANCE PROJECT PLAN FOR LAND DISPOSAL RESTRICTIONS PROGRAM ("BDAT"), EPA/530-SW-87-011, March 1987. It is a groundwater monitoring constituent as listed in Appendix IX, 40 CFR Part 264, 51 FR 26639, July 24, 1986.

regulation in K102 is 2-nitrophenol.<sup>1</sup> These two organic constituents are not on the BDAT list of constituents. However, the Agency considers these two constituents to be indicators of complete incineration of organic constituents in either K101 or K102 waste.

The Agency collected performance data for treatment of listed waste codes, K101 and K102, by rotary kiln incineration. The Agency has determined that the performance data for rotary kiln incineration indicate significant treatment of the BDAT list organic constituents in waste codes K101 and K102.

For both K101 and K102 nonwastewaters the following nine BDAT list metal constituent are proposed for regulation: antimony, arsenic, barium, cadmium, chromium, copper, lead, nickel, and zinc. The Agency is deferring the antimony, arsenic and barium treatment standards until a later date. The nine listed metals are proposed for regulation in the "derived from" forms of K101 and K102 nonwastewaters. These "derived from" forms are the ash generated from incineration, and metals precipitated from wastewater treatment. BDAT treatment standards for these nonwastewaters are proposed based on metals stabilization. No testing was performed on representative samples of K101 and K102. Therefore, metals stabilization performance data was transferred from EPA hazardous waste number, F006 based on waste characteristics affecting performance.

## Wastewaters

For K101 and K102 wastewaters, one (1) organic constituent and five (5) BDAT list metal constituents are being proposed for regulation in K101 and K102. The one organic constituent in K101 being proposed is 2-nitroaniline. The one organic constituent proposed for regulation for K102 is 2-nitrophenol. The proposed metal constituents are antimony, arsenic, cadmium, lead, and mercury. A detailed discussion of the selection of constituents to be regulated is presented in Section 5 of this document.

BDAT treatment standards for wastewater forms of K101 and K102 are proposed based on performance data from a treatment system consisting of chemical precipitation and metals stabilization of the resulting residuals. No testing was performed on representative samples of K101 and K102. Therefore, chemical precipitation treatment data was transferred from characteristic waste, D004, also produced by this industry. A detailed discussion of the transfer of data is presented in Section 6 of this document.

The following tables list the specific BDAT treatment standards for wastes identified as K101 and K102. The Agency is setting standards for K101 and K102 on two types of analyses. For organic and inorganic (other than metal) constituents, the Agency is basing standards on analysis of total constituent

concentrations. For metal constituents the Agency is basing standards on analysis of leachate. The leachate is obtained from the Toxicity Characteristic Leaching Procedure (TCLP) found in Appendix I of 40 CFR Part 268. The units for total constituent concentration are in parts per million (ppm) on a weight by weight (mg/kg) basis for nonwastewater and in parts per million (ppm) on a weight by volume (mg/l) basis for wastewater. The units for leachate are in parts per million (ppm) on a weight by volume (mg/l) basis.

# BDAT TREATMENT STANDARDS FOR K101/K102 WASTES

## WASTEWATER

	<u>K101</u>	<u>K102</u>
<u>Regulated Constituents</u>	<u>Total Composition (mg/l)</u>	
2-Nitroaniline	0.266	NR
2-Nitrophenol	NR	0.028
	<u>TCLP (mg/l)</u>	
Antimony	**	**
Arsenic	2.036	2.036
Cadmium	0.238	0.238
Lead	0.110	0.110
Mercury	0.027	0.027

## NONWASTEWATER

	<u>K101</u>	<u>K102</u>
<u>Regulated Constituents</u>	<u>Total Concentration (mg/kg)</u>	
2-Nitroaniline	14.000	NR
2-Nitrophenol	NR	13.328
	<u>TCLP (mg/l)</u>	
Antimony	**	**
Arsenic	**	**
Barium	**	**
Cadmium	0.066	0.066
Chromium	3.8	3.8
Copper	0.71	0.71
Lead	0.53	0.53
Nickel	0.31	0.31
Zinc	0.086	0.086

\*\* - Deferred for proposed regulation until later date.

NR = Not regulated since it is not present at treatable levels.

## 1. INTRODUCTION

This section of the background document presents a summary of the legal authority pursuant to which the BDAT treatment standards were developed, a summary of EPA's promulgated methodology for developing BDAT, and finally a discussion of the petition process that should be followed to request a variance from the BDAT treatment standards.

### 1.1 Legal Background

#### 1.1.1 Requirements Under HSWA

The Hazardous and Solid Waste Amendments of 1984 (HSWA), which were enacted on November 8, 1984, and which amended the Resource Conservation and Recovery Act of 1976 (RCRA), impose substantial new responsibilities on those who handle hazardous waste. In particular, the amendments require the Agency to promulgate regulations that restrict the land disposal of untreated hazardous wastes. In its enactment of HSWA, Congress stated explicitly that "reliance on land disposal should be minimized or eliminated, and land disposal, particularly landfill and surface impoundment, should be the least favored method for managing hazardous wastes" (RCRA section 1002(b)(7), 42 U.S.C. 6901(b)(7)).

One part of the amendments specifies dates on which particular groups of untreated hazardous wastes will be prohibited from land disposal unless "it has been demonstrated to the Administrator, to a reasonable degree of certainty, that there will be no migration of hazardous constituents from the disposal unit or injection zone for as long as the wastes remain hazardous" (RCRA section 3004(d)(1), (e)(1), (g)(5), 42 U.S.C. 6924 (d)(1), (e)(1), (g)(5)).

For the purpose of the restrictions, HSWA defines land disposal "to include, but not be limited to, any placement of... hazardous waste in a landfill, surface impoundment, waste pile, injection well, land treatment facility, salt dome formation, salt bed formation, or underground mine or cave" (RCRA section 3004(k), 42 U.S.C. 6924(k)). Although HSWA defines land disposal to include injection wells, such disposal of solvents, dioxins, and certain other wastes, known as the California List wastes, is covered on a separate schedule (RCRA section 3004(f)(2), 42 U.S.C. 6924 (f)(2)). This schedule requires that EPA propose land disposal restrictions for deep well injection by August 8, 1988.

The amendments also require the Agency to set "levels or methods of treatment, if any, which substantially diminish the toxicity of the waste or substantially reduce the likelihood of migration of hazardous constituents from the waste so that

short-term and long-term threats to human health and the environment are minimized" (RCRA section 3004(m)(1), 42 U.S.C. 6924 (m)(1)). Wastes that meet treatment standards established by EPA are not prohibited and may be land disposed. In setting treatment standards for listed or characteristic wastes, EPA may establish different standards for particular wastes within a single waste code with differing treatability characteristics. One such characteristic is the physical form of the waste. This frequently leads to different standards for wastewaters and nonwastewaters.

Alternatively, EPA can establish a treatment standard that is applicable to more than one waste code when, in EPA's judgment, all the waste can be treated to the same concentration. In those instances where a generator can demonstrate that the standard promulgated for the generator's waste cannot be achieved, the Agency also can grant a variance from a treatment standard by revising the treatment standard for that particular waste through rulemaking procedures. (A further discussion of treatment variances is provided in Section 1.3.)

The land disposal restrictions are effective when promulgated unless the Administrator grants a national variance and establishes a different date (not to exceed 2 years beyond the statutory deadline) based on "the earliest date on which adequate alternative treatment, recovery, or disposal capacity



which protects human health and the environment will be available" (RCRA section 3004(h)(2), 42 U.S.C. 6924 (h)(2)).

If EPA fails to set a treatment standard by the statutory deadline for any hazardous waste in the First Third or Second Third of the schedule (see Section 1.1.2), the waste may not be disposed in a landfill or surface impoundment unless the facility is in compliance with the minimum technological requirements specified in section 3004(o) of RCRA. In addition, prior to disposal, the generator must certify to the Administrator that the availability of treatment capacity has been investigated, and it has been determined that disposal in a landfill or surface impoundment is the only practical alternative to treatment currently available to the generator. This restriction on the use of landfills and surface impoundments applies until EPA sets a treatment standard for the waste or until May 8, 1990, whichever is sooner. If the Agency fails to set a treatment standard for any ranked hazardous waste by May 8, 1990, the waste is automatically prohibited from land disposal unless the waste is placed in a land disposal unit that is the subject of a successful "no migration" demonstration (RCRA section 3004(g), 42 U.S.C. 6924(g)). "No migration" demonstrations are based on case-specific petitions that show there will be no migration of hazardous constituents from the unit for as long as the waste remains hazardous.

### 1.1.2 Schedule for Developing Restrictions

Under section 3004(g) of RCRA, EPA was required to establish a schedule for developing treatment standards for all wastes that the Agency had listed as hazardous by November 8, 1984.

Section 3004(g) required that this schedule consider the intrinsic hazards and volumes associated with each of these wastes. The statute required EPA to set treatment standards according to the following schedule:

1. Solvents and dioxins standards must be promulgated by November 8, 1986;
2. The "California List" must be promulgated by July 8, 1987;
3. At least one-third of all listed hazardous wastes must be promulgated by August 8, 1988 (First Third);
4. At least two-thirds of all listed hazardous wastes must be promulgated by June 8, 1989 (Second Third); and
5. All remaining listed hazardous wastes and all hazardous wastes identified as of November 8, 1984, by one or more of the characteristics defined in 40 CFR Part 261 must be promulgated by May 8, 1990 (Third Third).

The statute specifically identified the solvent wastes as those covered under waste codes F001, F002, F003, F004, and F005; it identified the dioxin-containing hazardous wastes as those covered under waste codes F020, F021, F022, and F023.

Wastes collectively known as the California List wastes, defined under section 3004(d) of HSWA, are liquid hazardous wastes containing metals, free cyanides, PCBs, corrosives (i.e.,

a pH less than or equal to 2.0), and any liquid or nonliquid hazardous waste containing halogenated organic compounds (HOCs) above 0.1 percent by weight. Rules for the California List were proposed on December 11, 1986, and final rules for PCBs, corrosives, and HOC-containing wastes were established August 12, 1987. In that rule, EPA elected not to establish standards for metals. Therefore, the statutory limits became effective.

On May 28, 1986, EPA published a final rule (51 FR 19300) that delineated the specific waste codes that would be addressed by the First Third, Second Third, and Third Third. This schedule is incorporated into 40 CFR 268.10, .11, and .12.

## 1.2 Summary of Promulgated BDAT Methodology

In a November 7, 1986, rulemaking, EPA promulgated a technology-based approach to establishing treatment standards under section 3004(m). Section 3004(m) also specifies that treatment standards must "minimize" long- and short-term threats to human health and the environment arising from land disposal of hazardous wastes.

Congress indicated in the legislative history accompanying the HSWA that "[t]he requisite levels of [sic] methods of treatment established by the Agency should be the best that has

been demonstrated to be achievable," noting that the intent is "to require utilization of available technology" and not a "process which contemplates technology-forcing standards" (Vol. 130 Cong. Rec. S9178 (daily ed., July 25, 1984)). EPA has interpreted this legislative history as suggesting that Congress considered the requirement under section 3004(m) to be met by application of the best demonstrated and achievable (i.e., available) technology prior to land disposal of wastes or treatment residuals. Accordingly, EPA's treatment standards are generally based on the performance of the best demonstrated available technology (BDAT) identified for treatment of the hazardous constituents. This approach involves the identification of potential treatment systems, the determination of whether they are demonstrated and available, and the collection of treatment data from well-designed and well-operated systems.

The treatment standards, according to the statute, can represent levels or methods of treatment, if any, that substantially diminish the toxicity of the waste or substantially reduce the likelihood of migration of hazardous constituents. Wherever possible, the Agency prefers to establish BDAT treatment standards as "levels" of treatment (i.e., performance standards), rather than adopting an approach that would require the use of specific treatment "methods." EPA believes that concentration-based treatment levels offer the regulated

community greater flexibility to develop and implement compliance strategies, as well as an incentive to develop innovative technologies.

#### 1.2.1 Waste Treatability Group

In developing the treatment standards, EPA first characterizes the waste(s). As necessary, EPA may establish treatability groups for wastes having similar physical and chemical properties. That is, if EPA believes that wastes represented by different waste codes could be treated to similar concentrations using identical technologies, the Agency combines the codes into one treatability group. EPA generally considers wastes to be similar when they are both generated from the same industry and from similar processing stages. In addition, EPA may combine two or more separate wastes into the same treatability group when data are available showing that the waste characteristics affecting performance are similar or that one waste would be expected to be less difficult to treat.

Once the treatability groups have been established, EPA collects and analyzes data on identified technologies used to treat the wastes in each treatability group. The technologies evaluated must be demonstrated on the waste or a similar waste and must be available for use.

### 1.2.2 Demonstrated and Available Treatment Technologies

Consistent with legislative history, EPA considers demonstrated technologies to be those that are used to treat the waste of interest or a similar waste with regard to parameters that affect treatment selection (see November 7, 1986, 51 FR 40588). EPA also will consider as treatment those technologies used to separate or otherwise process chemicals and other materials. Some of these technologies clearly are applicable to waste treatment, since the wastes are similar to raw materials processed in industrial applications.

For most of the waste treatability groups for which EPA will promulgate treatment standards, EPA will identify demonstrated technologies either through review of literature related to current waste treatment practices or on the basis of information provided by specific facilities currently treating the waste or similar wastes.

In cases where the Agency does not identify any facilities treating wastes represented by a particular waste treatability group, EPA may transfer a finding of demonstrated treatment. To do this, EPA will compare the parameters affecting treatment selection for the waste treatability group of interest to other wastes for which demonstrated technologies already have been determined. The parameters affecting treatment selection and

their use for this waste are described in Section 3.2 of this document. If the parameters affecting treatment selection are similar, then the Agency will consider the treatment technology also to be demonstrated for the waste of interest. For example, EPA considers rotary kiln incineration to be a demonstrated technology for many waste codes containing hazardous organic constituents, high total organic content, and high filterable solids content, regardless of whether any facility is currently treating these wastes. The basis for this determination is data found in literature and data generated by EPA confirming the use of rotary kiln incineration on wastes having the above characteristics.

If no commercial treatment or recovery operations are identified for a waste or wastes with similar physical or chemical characteristics that affect treatment selection, the Agency will be unable to identify any demonstrated treatment technologies for the waste, and, accordingly, the waste will be prohibited from land disposal (unless handled in accordance with the exemption and variance provisions of the rule). The Agency is, however, committed to establishing treatment standards as soon as new or improved treatment processes are demonstrated (and available).

Operations only available at research facilities, pilot- and bench- scale operations, will not be considered in identifying

demonstrated treatment technologies for a waste because these technologies would not necessarily be "demonstrated."

Nevertheless, EPA may use data generated at research facilities in assessing the performance of demonstrated technologies.

As discussed earlier, Congress intended that technologies used to establish treatment standards under section 3004(m) be not only "demonstrated," but also available. To decide whether demonstrated technologies may be considered "available," the Agency determines whether they (1) are commercially available and (2) substantially diminish the toxicity of the waste or substantially reduce the likelihood of migration of hazardous constituents from the waste.

EPA will only set treatment standards based on a technology that meets the above criteria. Thus, the decision to classify a technology as "unavailable" will have a direct impact on the treatment standard. If the best technology is unavailable, the treatment standard will be based on the next best treatment technology determined to be available. To the extent that the resulting treatment standards are less stringent, greater concentrations of hazardous constituents in the treatment residuals could be placed in land disposal units.

There also may be circumstances in which EPA concludes that for a given waste none of the demonstrated treatment technologies



are "available" for purposes of establishing the 3004(m) treatment performance standards. Subsequently, these wastes will be prohibited from continued placement in or on the land unless managed in accordance with applicable exemptions and variance provisions. The Agency is, however, committed to establishing new treatment standards as soon as new or improved treatment processes become "available."

(1) Proprietary or patented processes. If the demonstrated treatment technology is a proprietary or patented process that is not generally available, EPA will not consider the technology in its determination of the treatment standards. EPA will consider proprietary or patented processes available if it determines that the treatment method can be purchased or licensed from the proprietor or is a commercially available treatment. The services of the commercial facility offering this technology often can be purchased even if the technology itself cannot be purchased.

(2) Substantial treatment. To be considered "available," a demonstrated treatment technology must "substantially diminish the toxicity" of the waste or "substantially reduce the likelihood of migration of hazardous constituents" from the waste in accordance with section 3004(m). By requiring that substantial treatment be achieved in order to set a treatment standard, the statute ensures that all wastes are adequately

treated before being placed in or on the land and ensures that the Agency does not require a treatment method that provides little or no environmental benefit. Treatment will always be deemed substantial if it results in nondetectable levels of the hazardous constituents of concern. If nondetectable levels are not achieved, then a determination of substantial treatment will be made on a case-by-case basis. This approach is necessary because of the difficulty of establishing a meaningful guideline that can be applied broadly to the many wastes and technologies to be considered. EPA will consider the following factors in an effort to evaluate whether a technology provides substantial treatment on a case-by-case basis:

- o Number and types of constituents treated;
- o Performance (concentration of the constituents in the treatment residuals); and
- o Percent of constituents removed.

If none of the demonstrated treatment technologies achieve substantial treatment of a waste, the Agency cannot establish treatment standards for the constituents of concern in that waste.

### 1.2.3 Collection of Performance Data

Performance data on the demonstrated available technologies are evaluated by the Agency to determine whether the data are

representative of well-designed and well-operated treatment systems. Only data from well-designed and well-operated systems are included in determining BDAT. The data evaluation includes data already collected directly by EPA and/or data provided by industry. In those instances where additional data are needed to supplement existing information, EPA collects additional data through a sampling and analysis program. The principal elements of this data collection program are: (1) identification of facilities for site visits, (2) an engineering site visit, (3) a Sampling and Analysis Plan, (4) a sampling visit, and (5) an Onsite Engineering Report.

(1) Identification of facilities for site visits. To identify facilities that generate and/or treat the waste of concern, EPA uses a number of information sources. These include Stanford Research Institute's Directory of Chemical Producers; EPA's Hazardous Waste Data Management System (HWDMS); the 1986 Treatment, Storage, Disposal Facility (TSDF) National Screening Survey; and EPA's Industry Studies Data Base. In addition, EPA contacts trade associations to inform them that the Agency is considering visits to facilities in their industry and to solicit their assistance in identifying facilities for EPA to consider in its treatment sampling program.

After identifying facilities that treat the waste, EPA uses this hierarchy to select sites for engineering visits:

(1) generators treating single wastes on site; (2) generators treating multiple wastes together on site; (3) commercial treatment, storage, and disposal facilities (TSDFs); and (4) EPA in-house treatment. This hierarchy is based on two concepts: (1) to the extent possible, EPA should develop treatment standards from data produced by treatment facilities handling only a single waste, and (2) facilities that routinely treat a specific waste have had the best opportunity to optimize design parameters. Although excellent treatment can occur at many facilities that are not high in this hierarchy, EPA has adopted this approach to avoid, when possible, ambiguities related to the mixing of wastes before and during treatment.

When possible, the Agency will evaluate treatment technologies using commercially operated systems. If performance data from properly designed and operated commercial treatment methods for a particular waste or a waste judged to be similar are not available, EPA may use data from research facilities operations. Whenever research facility data are used, EPA will explain in the preamble and background document why such data were used and will request comments on the use of such data.

Although EPA's data bases provide information on treatment for individual wastes, the data bases rarely provide data that support the selection of one facility for sampling over another. In cases where several treatment sites appear to fall into the

same level of the hierarchy, EPA selects sites for visits strictly on the basis of which facility could most expeditiously be visited and later sampled if justified by the engineering visit.

(2) Engineering site visit. Once a treatment facility has been selected, an engineering site visit is made to confirm that a candidate for sampling meets EPA's criteria for a well-designed facility and to ensure that the necessary sampling points can be accessed to determine operating parameters and treatment effectiveness. During the visit, EPA also confirms that the facility appears to be well operated, although the actual operation of the treatment system during sampling is the basis for EPA's decisions regarding proper operation of the treatment unit. In general, the Agency considers a well-designed facility to be one that contains the unit operations necessary to treat the various hazardous constituents of the waste, as well as to control other nonhazardous materials in the waste that may affect treatment performance.

In addition to ensuring that a system is reasonably well designed, the engineering visit examines whether the facility has a way to measure the operating parameters that affect performance of the treatment system during the waste treatment period. For example, EPA may choose not to sample a treatment system that operates in a continuous mode, for which an important operating

parameter cannot be continuously recorded. In such systems, instrumentation is important in determining whether the treatment system is operating at design values during the waste treatment period.

(3) Sampling and Analysis Plan. If after the engineering site visit the Agency decides to sample a particular plant, the Agency will then develop a site-specific Sampling and Analysis Plan (SAP) according to the Generic Quality Assurance Project Plan for the Land Disposal Restriction Program ("BDAT"), EPA/530-SW-87-011. In brief, the SAP discusses where the Agency plans to sample, how the samples will be taken, the frequency of sampling, the constituents to be analyzed and the method of analysis, operational parameters to be obtained, and specific laboratory quality control checks on the analytical results.

The Agency will generally produce a draft of the site-specific Sampling and Analysis Plan within 2 to 3 weeks of the engineering visit. The draft of the SAP is then sent to the plant for review and comment. With few exceptions, the draft SAP should be a confirmation of data collection activities discussed with the plant personnel during the engineering site visit. EPA encourages plant personnel to recommend any modifications to the SAP that they believe will improve the quality of the data.

It is important to note that sampling of a plant by EPA does not mean that the data will be used in the development of treatment standards for BDAT. EPA's final decision on whether to use data from a sampled plant depends on the actual analysis of the waste being treated and on the operating conditions at the time of sampling. Although EPA would not plan to sample a facility that was not ostensibly well designed and well operated, there is no way to ensure that at the time of the sampling the facility will not experience operating problems. Additionally, EPA statistically compares its test data to suitable industry-provided data, where available, in its determination of what data to use in developing treatment standards. The methodology for comparing data is presented later in this section.

(Note: Facilities wishing to submit data for consideration in the development of BDAT standards should, to the extent possible, provide sampling information similar to that acquired by EPA. Such facilities should review the Generic Quality Assurance Project Plan for the Land Disposal Restriction Program ("BDAT"), which delineates all of the quality control and quality assurance measures associated with sampling and analysis. (Quality assurance and quality control procedures are summarized in Section 1.2.6 of this document.)

(4) Sampling visit. The purpose of the sampling visit is to collect samples that characterize the performance of the treatment system and to document the operating conditions that existed during the waste treatment period. At a minimum, the Agency attempts to collect sufficient samples of the untreated waste and solid and liquid treatment residuals so that variability in the treatment process can be accounted for in the development of the treatment standards. To the extent practicable, and within safety constraints, EPA or its contractors collect all samples and ensure that chain-of-custody procedures are conducted so that the integrity of the data is maintained.

In general, the samples collected during the sampling visit will have already been specified in the SAP. In some instances, however, EPA will not be able to collect all planned samples because of changes in the facility operation or plant upsets; EPA will explain any such deviations from the SAP in its follow-up Onsite Engineering Report.

(5) Onsite Engineering Report. EPA summarizes all its data collection activities and associated analytical results for testing at a facility in a report referred to as the Onsite Engineering Report (OER). This report characterizes the waste(s) treated, the treated residual concentrations, the design and operating data, and all analytical results including methods used



and accuracy results. This report also describes any deviations from EPA's suggested analytical methods for hazardous wastes (see Test Methods for Evaluating Solid Waste, SW-846, Third Edition, November 1986).

After the Onsite Engineering Report is completed, the report is submitted to the plant for review. This review provides the plant with a final opportunity to claim any information contained in the report as confidential. Following the review and incorporation of comments, as appropriate, the report is made available to the public with the exception of any material claimed as confidential by the plant.

#### 1.2.4 Hazardous Constituents Considered and Selected for Regulation

(1) Development of BDAT list. The list of hazardous constituents within the waste codes that are targeted for treatment is referred to by the Agency as the BDAT constituent list. This list, provided as Table 1-1, is derived from the constituents presented in 40 CFR Part 261, Appendices VII and VIII, as well as several ignitable constituents used as the basis of listing wastes as F003 and F005. These sources provide a comprehensive list of hazardous constituents specifically regulated under RCRA. The BDAT list consists of those constituents that can be analyzed using methods published in SW-846, Third Edition.

TABLE 1-1 BDAT Constituent List

BDAT reference no.	Parameter	CAS No.
<u>Volatiles</u>		
222	Acetone	67-64-1
1	Acetonitrile	75-05-8
2	Acrolein	107-02-8
3	Acrylonitrile	107-13-1
4	Benzene	71-43-2
5	Bromodichloromethane	75-27-4
6	Bromomethane	74-83-9
223	n-Butyl alcohol	71-36-3
7	Carbon Tetrachloride	56-23-5
8	Carbon disulfide	75-15-0
9	Chlorobenzene	108-90-7
10	2-Chloro-1,3-butadiene	126-99-8
11	Chlorodibromomethane	124-48-1
12	Chloroethane	75-00-3
13	2-Chloroethyl vinyl ether	110-75-8
14	Chloroform	67-66-3
15	Chloromethane	74-87-3
16	3-Chloropropene	107-05-1
17	1,2-Dibromo-3-chloropropane	96-12-8
18	1,2-Dibromoethane	106-93-4
19	Dibromomethane	74-95-3
20	trans-1,4-Dichloro-2-butene	110-57-6
21	Dichlorodifluoromethane	75-71-8
22	1,1-Dichloroethane	75-35-3
23	1,2-Dichloroethane	107-06-2
24	1,1-Dichloroethylene	75-35-4
25	trans-1,2-Dichloroethene	156-60-5
26	1,2-Dichloropropane	78-87-5
27	trans-1,3-Dichloropropene	10061-02-6
28	cis-1,3-Dichloropropene	10061-01-5
29	1,4-Dioxane	123-91-1
224	2-Ethoxyethanol	110-80-5
225	Ethyl acetate	141-78-6
226	Ethyl benzene	100-41-4
30	Ethyl cyanide	107-12-0
227	Ethyl ether	60-29-7
31	Ethyl methacrylate	97-63-2
214	ethylene oxide	75-21-8
32	Iodomethane	74-88-4

Continued

TABLE 1-1 (Continued)

BDAT reference no.	Parameter	CAS No.
<u>Volatiles (cont.)</u>		
33	Isobutyl alcohol	78-83-1
228	Methanol	67-56-1
34	Methyl ethyl ketone	78-93-3
229	Methyl isobutyl ketone	108-10-1
35	Methyl methacrylate	80-62-6
37	Methylacrylonitrile	126-98-7
38	Methylene chloride	75-09-2
230	2-Nitropropane	79-46-9
39	Pyridine	110-86-1
40	1,1,1,2-Tetrachloroethane	630-20-6
41	1,1,2,2-Tetrachloroethane	79-34-5
42	Tetrachloroethene	127-18-4
43	Toluene	108-88-3
44	Tribromomethane	75-25-2
45	1,1,1-Trichloroethane	71-55-6
46	1,1,2-Trichloroethane	79-00-5
47	Trichloroethene	79-01-6
48	Trichloromonofluoromethane	75-69-4
49	1,2,3-Trichloropropane	96-18-4
231	1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1
50	Vinyl chloride	75-01-4
215	1,2-Xylene	97-47-6
216	1,3-Xylene	108-38-3
217	1,4-Xylene	106-44-5
<u>Semivolatiles</u>		
51	Acenaphthalene	208-96-8
52	Acenaphthene	83-32-9
53	Acetophenone	96-86-2
54	2-Acetylaminofluorene	53-96-3
55	4-Aminobiphenyl	92-67-1
56	Aniline	62-53-3
57	Anthracene	120-12-7
58	Aramite	140-57-8
59	Benz(a)anthracene	56-55-3
218	Benzal chloride	98-87-3
60	Benzenethiol	108-98-6
61	Benzidine	92-87-5
62	Benzo(a)pyrene	50-32-8

Continued

TABLE 1-1 (Continued)

BDAT reference no.	Parameter	CAS No.
<u>Semivolatiles (cont.)</u>		
63	Benzo(b)fluoranthene	205-99-2
64	Benzo(ghi)perylene	191-24-2
65	Benzo(k)fluoranthene	207-08-9
66	p-Benzoquinone	106-51-4
67	Bis(2-chloroethoxy)ethane	111-91-1
68	Bis(2-chloroethyl)ether	111-44-4
69	Bis(2-chloroisopropyl)ether	39638-32-9
70	Bis(2-ethylhexyl)phthalate	117-81-7
71	4-Bromophenyl phenyl ether	101-55-3
72	Butyl benzyl phthalate	85-68-7
73	2-sec-Butyl-4,6-dinitrophenol	88-85-7
74	p-Chloroaniline	106-47-8
75	Chlorobenzilate	510-15-6
76	p-Chloro-m-cresol	59-50-7
77	2-Chloronaphthalene	91-58-7
78	2-Chlorophenol	95-57-8
79	3-Chloropropionitrile	54-27-67
80	Chrysene	218-01-9
81	ortho-Cresol	95-48-7
82	para-Cresol	106-44-5
232	Cyclohexanone	108-94-1
83	Dibenz(a,h)anthracene	53-70-3
84	Dibenzo(a,e)pyrene	192-65-4
85	Dibenzo(a,i)pyrene	189-55-9
86	m-Dichlorobenzene	541-73-1
87	o-Dichlorobenzene	95-50-1
88	p-Dichlorobenzene	106-46-7
89	3,3'-Dichlorobenzidine	91-94-1
90	2,4-Dichlorophenol	120-83-2
91	2,6-Dichlorophenol	87-65-0
92	Diethyl phthalate	84-66-2
93	3,3'-Dimethoxybenzidine	119-90-4
94	p-Dimethylaminoazobenzene	60-11-7
95	3,3'-Dimethylbenzidine	119-93-7
96	2,4-Dimethylphenol	105-67-9
97	Dimethyl phthalate	131-11-3
98	Di-n-butyl phthalate	84-74-2
99	1,4-Dinitrobenzene	100-25-4
100	4,6-Dinitro-o-cresol	534-52-1
101	2,4-Dinitrophenol	51-28-5

Continued

TABLE 1-1 (Continued)

BDAT reference no.	Parameter	CAS No.
<u>Semivolatiles (cont.)</u>		
102	2,4-Dinitrotoluene	121-14-2
103	2,6-Dinitrotoluene	606-20-2
104	Di-n-octyl phthalate	117-84-0
105	Di-n-propylnitrosamine	621-64-7
106	Diphenylamine	122-39-4
219	Diphenylnitrosamine	86-30-6
107	1,2-Diphenylhydrazine	122-66-7
108	Fluoranthene	206-44-0
109	Fluorene	86-73-7
110	Hexachlorobenzene	118-74-1
111	Hexachlorobutadiene	87-68-3
112	Hexachlorocyclopentadiene	77-47-4
113	Hexachloroethane	67-72-1
114	Hexachlorophene	70-30-4
115	Hexachloropropene	1888-71-7
116	Indeno(1,2,3-cd)pyrene	193-39-5
117	Isosafrole	120-58-1
118	Methapyrilene	91-80-5
119	3-Methycholanthrene	56-49-5
120	4,4'-Methylenebis(2-chloroaniline)	101-14-4
36	Methyl methanesulfonate	66-27-3
121	Napthalene	91-20-3
122	1,4-Naphthoquinone	130-15-4
123	1-Napthylamine	134-32-7
124	2-Napthylamine	91-59-8
125	p-Nitroaniline	100-01-6
126	Nitrobenzene	98-95-3
127	4-Nitrophenol	100-02-7
128	N-Nitrosodi-n-butylamine	924-16-3
129	N-Nitrosodiethylamine	55-18-5
130	N-Nitrosodimethylamine	62-75-9
131	N-Nitrosomethylethylamine	10595-95-6
132	N-Nitrosomorpholine	59-89-2
133	N-Nitrosopiperidine	100-75-4
134	n-Nitrosopyrrolidine	930-55-2
135	2-Methyl-5-nitroaniline	99-55-5
136	Pentachlorobenzene	608-93-5
137	Pentachloroethane	76-01-7
138	Pentachloronitrobenzene	82-68-8

Continued

TABLE 1-1 (Continued)

BDAT reference no.	Parameter	CAS No.
<u>Semivolatiles (cont.)</u>		
139	Pentachlorophenol	87-86-5
140	Phenacetin	62-44-2
141	Phenanthrene	85-01-8
142	Phenol	108-85-2
220	Phthalic anhydride	85-44-9
143	2-Picoline	109-06-8
144	Pronamide	23950-58-5
145	Pyrene	129-00-0
146	Resorcinol	108-46-3
147	Safrole	94-59-7
148	1,2,4,5-Tetrachlorobenzene	95-94-3
149	2,3,4,6-Tetrachlorophenol	58-90-2
150	1,2,4-Trichlorobenzene	120-82-1
151	2,4,5-Trichlorophenol	95-95-4
152	2,4,6-Trichlorophenol	88-06-2
153	Tris(2,3-dibromopropyl)phosphate	126-72-7
<u>Metals</u>		
154	Antimony	7440-36-0
155	Arsenic	7440-38-2
156	Barium	7440-39-3
157	Beryllium	7440-41-7
158	Cadmium	7440-47-9
159	Chromium (total)	7440-50-3
221	Chromium (hexavalent)	-
160	Copper	7440-50-8
161	Lead	7439-92-1
162	Mercury	7439-97-6
163	Nickel	7440-02-0
164	Selenium	7782-49-2
165	Silver	7440-22-4
166	Thallium	7440-28-0
167	Vanadium	7440-62-2
168	Zinc	7440-66-6
<u>Inorganics</u>		
169	Cyanide	57-12-5
170	Fluoride	16964-48-8
171	Sulfide	8496-25-8

Continued

TABLE 1-1 (Continued)

BDAT reference no.	Parameter	CAS No.
<u>Organochlorine Pesticides</u>		
172	Aldrin	309-00-2
173	alpha-BHC	319-84-6
174	beta-BHC	319-85-7
175	delta-BHC	319-86-8
176	gamma-BHC	58-89-9
177	Chlordane	57-74-9
178	DDD	72-54-8
179	DDE	72-55-9
180	DDT	50-29-3
181	Dieldrin	60-57-1
182	Endosulfan I	939-98-8
183	Endosulfan II	33213-6-5
184	Endrin	72-20-8
185	Endrin aldehyde	7421-93-4
186	Heptachlor	76-44-8
187	Heptachlor epoxide	1024-57-3
188	Isodrin	465-73-6
189	Kepone	143-50-0
190	Mehoxychlor	72-43-5
191	Toxaphene	8001-35-2
<u>Phenoxyacetic Acid Herbicides</u>		
192	2,4-Dichlorophenoxyacetic acid	94-75-7
193	Silvex	93-72-1
194	2,4,5-T	93-76-5
<u>Organophosphorous Insecticides</u>		
195	Disulfoton	298-04-4
196	Famphur	52-85-7
197	Methyl parathion	298-00-0
198	Parathion	56-38-2
199	Phorate	298-02-2
<u>PCBs</u>		
200	Aroclor 1016	12674-11-2
201	Aroclor 1221	11104-28-2
202	Aroclor 1232	11141-16-5

Continued

TABLE 1-1 (Continued)

BDAT reference no.	Parameter	CAS No.
<u>PCBs (cont.)</u>		
203	Aroclor 1242	53469-21-9
204	Aroclor 1248	12672-29-6
205	Aroclor 1254	11097-69-1
206	Aroclor 1260	11096-82-5
<u>Dioxins and Furans</u>		
207	Hexachlorodibenzo-p-dioxins	-
208	Hexachlorodibenzofuran	-
209	Pentachlorodibenzo-p-dioxins	-
210	Pentachlorodibenzofuran	-
211	Tetrachlorodibenzo-p-dioxins	-
212	Tetrachlorodibenzofuran	-
213	2,3,7,8-Tetrachlorodibenzo-p-dioxin	1746-01-6



The initial BDAT constituent list was published in EPA's Generic Quality Assurance Project Plan, March 1987 (EPA/530-SW-87-011). Additional constituents will be added to the BDAT constituent list as more key constituents are identified for specific waste codes or as new analytical methods are developed for hazardous constituents. For example, since the list was published in March 1987, 18 additional constituents (hexavalent chromium, xylene (all three isomers), benzal chloride, phthalic anhydride, ethylene oxide, acetone, n-butyl alcohol, 2-ethoxyethanol, ethyl acetate, ethyl benzene, ethyl ether, methanol, methyl isobutyl ketone, 2-nitropropane, 1,1,2-trichloro-1,2,2-trifluoroethane, and cyclohexanone) have been added to the list.

Chemicals are listed in Appendix VIII if they are shown in scientific studies to have toxic, carcinogenic, mutagenic, or teratogenic effects on humans or other life-forms, and they include such substances as those identified by the Agency's Carcinogen Assessment Group as being carcinogenic. Including a constituent in Appendix VIII means that the constituent can be cited as a basis for listing toxic wastes.

Although Appendix VII, Appendix VIII, and the F003 and F005 ignitables provide a comprehensive list of RCRA-regulated hazardous constituents, not all of the constituents can be analyzed in a complex waste matrix. Therefore, constituents that

could not be readily analyzed in an unknown waste matrix were not included on the initial BDAT list. As mentioned above, however, the BDAT constituent list is a continuously growing list that does not preclude the addition of new constituents when analytical methods are developed.

There are five major reasons that constituents were not included on the BDAT constituent list:

1. Constituents are unstable. Based on their chemical structure, some constituents will either decompose in water or will ionize. For example, maleic anhydride will form maleic acid when it comes in contact with water and copper cyanide will ionize to form copper and cyanide ions. However, EPA may choose to regulate the decomposition or ionization products.
2. EPA-approved or verified analytical methods are not available. Many constituents, such as 1,3,5-trinitrobenzene, are not measured adequately or even detected using any of EPA's analytical methods published in SW-846 Third Edition.
3. The constituent is a member of a chemical group designated in Appendix VIII as not otherwise specified (N.O.S.). Constituents listed as N.O.S., such as chlorinated phenols, are a generic group of some types of chemicals for which a single analytical procedure is not available. The individual members of each such group need to be listed to determine whether the constituents can be analyzed. For each N.O.S. group, all those constituents that can be readily analyzed are included in the BDAT constituent list.
4. Available analytical procedures are not appropriate for a complex waste matrix. Some compounds, such as auramine, can be analyzed as a pure constituent. However, in the presence of other constituents, the recommended analytical method does not positively identify the constituent. The use of high pressure liquid chromatography (HPLC) presupposes a high expectation of finding the specific constituents of interest. In using this procedure to screen samples, protocols would have to be developed on a case-specific basis to verify the identity of constituents present in

the samples. Therefore, HPLC is not an appropriate analytical procedure for complex samples containing unknown constituents.

5. Standards for analytical instrument calibration are not commercially available. For several constituents, such as benz(c)acridine, commercially available standards of a "reasonably" pure grade are not available. The unavailability of a standard was determined by a review of catalogs from specialty chemical manufacturers.

Two constituents (fluoride and sulfide) are not specifically included in Appendices VII and VIII; however, these compounds are included on the BDAT list as indicator constituents for compounds from Appendices VII and VIII such as hydrogen fluoride and hydrogen sulfide, which ionize in water.

The BDAT constituent list presented in Table 1-1 is divided into the following nine groups:

- o Volatile organics;
- o Semivolatile organics;
- o Metals;
- o Other inorganics;
- o Organochlorine pesticides;
- o Phenoxyacetic acid herbicides;
- o Organophosphorous insecticides;
- o PCBs; and
- o Dioxins and furans.

The constituents were placed in these categories based on their chemical properties. The constituents in each group are expected to behave similarly during treatment and are also analyzed, with the exception of the metals and inorganics, by using the same analytical methods.

(2) Constituent selection analysis. The constituents that the Agency selects for regulation in each treatability group are, in general, those found in the untreated wastes at treatable concentrations. For certain waste codes, the target list for the untreated waste may have been shortened (relative to analyses performed to test treatment technologies) because of the extreme unlikelihood that the constituent will be present.

In selecting constituents for regulation, the first step is to summarize all the constituents that were found in the untreated waste at treatable concentrations. This process involves the use of the statistical analysis of variance (ANOVA) test, described in Section 1.2.6, to determine if constituent reductions were significant. The Agency interprets a significant reduction in concentration as evidence that the technology actually "treats" the waste.

There are some instances where EPA may regulate constituents that are not found in the untreated waste but are detected in the treated residual. This is generally the case where presence of the constituents in the untreated waste interferes with the quantification of the constituent of concern. In such instances, the detection levels of the constituent are relatively high, resulting in a finding of "not detected" when, in fact, the constituent is present in the waste.

After determining which of the constituents in the untreated waste are present at treatable concentrations, EPA develops a list of potential constituents for regulation. The Agency then reviews this list to determine if any of these constituents can be excluded from regulation because they would be controlled by regulation of other constituents in the list.

EPA performs this indicator analysis for two reasons: (1) it reduces the analytical cost burdens on the treater and (2) it facilitates implementation of the compliance and enforcement program. EPA's rationale for selection of regulated constituents for this waste code is presented in Section 5 of this background document.

(3) Calculation of standards. The final step in the calculation of the BDAT treatment standard is the multiplication of the average treatment value by a factor referred to by the Agency as the variability factor. This calculation takes into account that even well-designed and well-operated treatment systems will experience some fluctuations in performance. EPA expects that fluctuations will result from inherent mechanical limitations in treatment control systems, collection of treated samples, and analysis of these samples. All of the above fluctuations can be expected to occur at well-designed and well-operated treatment facilities. Therefore, setting treatment standards utilizing a variability factor should be viewed not as

a relaxing of section 3004(m) requirements, but rather as a function of the normal variability of the treatment processes. A treatment facility will have to be designed to meet the mean achievable treatment performance level to ensure that the performance levels remain within the limits of the treatment standard.

The Agency calculates a variability factor for each constituent of concern within a waste treatability group using the statistical calculation presented in Appendix A. The equation for calculating the variability factor is the same as that used by EPA for the development of numerous regulations in the Effluent Guidelines Program under the Clean Water Act. The variability factor establishes the instantaneous maximum based on the 99th percentile value.

There is an additional step in the calculation of the treatment standards in those instances where the ANOVA analysis shows that more than one technology achieves a level of performance that represents BDAT. In such instances, the BDAT treatment standard is calculated by first averaging the mean performance value for each technology for each constituent of concern and then multiplying that value by the highest variability factor among the technologies considered. This procedure ensures that all the BDAT technologies used as the basis for the standards will achieve full compliance.

#### 1.2.5 Compliance with Performance Standards

All the treatment standards reflect performance achieved by the best demonstrated available technology (BDAT). As such, compliance with these standards requires only that the treatment level be achieved prior to land disposal. It does not require the use of any particular treatment technology. While dilution of the waste as a means to comply with the standard is prohibited, wastes that are generated in such a way as to naturally meet the standard can be land disposed without treatment. With the exception of treatment standards that prohibit land disposal, all treatment standards proposed are expressed as a concentration level.

EPA has used both total constituent concentration and TCLP analyses of the treated waste as a measure of technology performance. EPA's rationale for when each of these analytical tests is used is explained in the following discussion.

For all organic constituents, EPA is basing the treatment standards on the total constituent concentration found in the treated waste. EPA based its decision on the fact that technologies exist to destroy the various organics compounds. Accordingly, the best measure of performance would be the extent to which the various organic compounds have been destroyed or the total amount of constituent remaining after treatment. (NOTE:

EPA's land disposal restrictions for solvent waste codes F001-F005 (51 FR 40572) use the TCLP value as a measure of performance. At the time that EPA promulgated the treatment standards for F001-F005, useful data were not available on total constituent concentrations in treated residuals and, as a result, the TCLP data were considered to be the best measure of performance.)

For all metal constituents, EPA is using both total constituent concentration and/or the TCLP as the basis for treatment standards. The total constituent concentration is being used when the technology basis includes a metal recovery operation. The underlying principle of metal recovery is the reduction of the amount of metal in a waste by separating the metal for recovery; therefore, total constituent concentration in the treated residual is an important measure of performance for this technology. Additionally, EPA also believes that it is important that any remaining metal in a treated residual waste not be in a state that is easily leachable; accordingly, EPA is also using the TCLP as a measure of performance. It is important to note that for wastes for which treatment standards are based on a metal recovery process, the facility has to comply with both the total constituent concentration and the TCLP prior to land disposal.



In cases where treatment standards for metals are not based on recovery techniques but rather on stabilization, EPA is using only the TCLP as a measure of performance. The Agency's rationale is that stabilization is not meant to reduce the concentration of metal in a waste but only to chemically minimize the ability of the metal to leach.

#### 1.2.6 Identification of BDAT

(1) Screening of treatment data. This section explains how the Agency determines which of the treatment technologies represent treatment by BDAT. The first activity is to screen the treatment performance data from each of the demonstrated and available technologies according to the following criteria:

1. Design and operating data associated with the treatment data must reflect a well-designed, well-operated system for each treatment data point. (The specific design and operating parameters for each demonstrated technology for this waste code are discussed in Section 3.2 of this document.)
2. Sufficient QA/QC data must be available to determine the true values of the data from the treated waste. This screening criterion involves adjustment of treated data to take into account that the type value may be different from the measured value. This discrepancy generally is caused by other constituents in the waste that can mask results or otherwise interfere with the analysis of the constituent of concern.
3. The measure of performance must be consistent with EPA's approach to evaluating treatment by type of constituents (e.g., total concentration data for organics, and total concentration and TCLP for metals in the leachate from the residual).

In the absence of data needed to perform the screening analysis, EPA will make decisions on a case-by-case basis as to whether to include the data. The factors included in this case-by-case analysis will be the actual treatment levels achieved, the availability of the treatment data and their completeness (with respect to the above criteria), and EPA's assessment of whether the untreated waste represents the waste code of concern. EPA's application of these screening criteria for this waste code is provided in Section 4 of this background document.

(2) Comparison of treatment data. In cases in which EPA has treatment data from more than one technology following the screening activity, EPA uses the statistical method known as analysis of variance (ANOVA) to determine if one technology performs significantly better than the others. This statistical method (summarized in Appendix A) provides a measure of the differences between two data sets. If EPA finds that one technology performs significantly better (i.e., the data sets are not homogeneous), BDAT treatment standards are the level of performance achieved by the best technology multiplied by the corresponding variability factor for each regulated constituent.

If the differences in the data sets are not statistically significant, the data sets are said to be homogeneous. Specifically, EPA uses the analysis of variance to determine

whether BDAT represents a level of performance achieved by only one technology or represents a level of performance achieved by more than one (or all) of the technologies. If the Agency finds that the levels of performance for one or more technologies are not statistically different, EPA averages the performance values achieved by each technology and then multiplies this value by the largest variability factor associated with any of the acceptable technologies. A detailed discussion of the treatment selection method and an example of how EPA chooses BDAT from multiple treatment systems is provided in Section A-1.

(3) Quality assurance/quality control. This section presents the principal quality assurance/quality control (QA/QC) procedures employed in screening and adjusting the data to be used in the calculation of treatment standards. Additional QA/QC procedures used in collecting and screening data for the BDAT program are presented in EPA's Generic Quality Assurance Project Plan for Land Disposal Restrictions Program ("BDAT") (EPA/530-SW-87-011, March 1987).

To calculate the treatment standards for the Land Disposal Restriction Rules, it is first necessary to determine the recovery value for each constituent (the amount of constituent recovered after spiking, which is the addition of a known amount of the constituent, minus the initial concentration in the samples divided by the amount added) for a spike of the treated

residual. Once the recovery value is determined, the following procedures are used to select the appropriate percent recovery value to adjust the analytical data:

1. If duplicate spike recovery values are available for the constituent of interest, the data are adjusted by the lowest available percent recovery value (i.e., the value that will yield the most conservative estimate of treatment achieved). However, if a spike recovery value of less than 20 percent is reported for a specific constituent, the data are not used to set treatment standards because the Agency does not have sufficient confidence in the reported value to set a national standard.
2. If data are not available for a specific constituent but are available for an isomer, then the spike recovery data are transferred from the isomer and the data are adjusted using the percent recovery selected according to the procedure described in (1) above.
3. If data are not available for a specific constituent but are available for a similar class of constituents (e.g., volatile organics, acid-extractable semivolatiles), then spike recovery data available for this class of constituents are transferred. All spike recovery values greater than or equal to 20 percent for a spiked sample are averaged and the constituent concentration is adjusted by the average recovery value. If spiked recovery data are available for more than one sample, the average is calculated for each sample and the data are adjusted by the lowest average value.
4. If matrix spike recovery data are not available for a set of data to be used to calculate treatment standards, then matrix spike recovery data are transferred from a waste that the Agency believes is a similar matrix (e.g., if the data are for an ash from incineration, then data from other incinerator ashes could be used). While EPA recognizes that transfer of matrix spike recovery data from a similar waste is not an exact analysis, this is considered the best approach for adjusting the data to account for the fact that most analyses do not result in extraction of 100 percent of the constituent. In assessing the recovery data to be transferred, the procedures outlined in (1), (2), and (3) above are followed.

The analytical procedures employed to generate the data used to calculate the treatment standards are listed in Appendix B of this document. In cases where alternatives or equivalent procedures and/or equipment are allowed in EPA's SW-846, Third Edition (November 1986) methods, the specific procedures and equipment used are also documented in this Appendix. In addition, any deviations from the SW-846, Third Edition, methods used to analyze the specific waste matrices are documented. It is important to note that the Agency will use the methods and procedures delineated in Appendix B to enforce the treatment standards presented in Section 6 of this document. Accordingly, facilities should use these procedures in assessing the performance of their treatment systems.

#### 1.2.7 BDAT Treatment Standards for "Derived-From" and "Mixed" Wastes

(1) Wastes from treatment trains generating multiple residues. In a number of instances, the proposed BDAT consists of a series of operations, each of which generates a waste residue. For example, the proposed BDAT for a certain waste code is based on solvent extraction, steam stripping, and activated carbon adsorption. Each of these treatment steps generates a waste requiring treatment--a solvent-containing stream from solvent extraction, a stripper overhead, and spent activated carbon. Treatment of these wastes may generate further residues; for instance, spent activated carbon (if not regenerated) could

be incinerated, generating an ash and possibly a scrubber water waste. Ultimately, additional wastes are generated that may require land disposal. With respect to these wastes, the Agency wishes to emphasize the following points:

1. All of the residues from treating the original listed wastes are likewise considered to be the listed waste by virtue of the derived-from rule contained in 40 CFR Part 261.3(c)(2). (This point is discussed more fully in (2) below.) Consequently, all of the wastes generated in the course of treatment would be prohibited from land disposal unless they satisfy the treatment standard or meet one of the exceptions to the prohibition.
2. The Agency's proposed treatment standards generally contain a concentration level for wastewaters and a concentration level for nonwastewaters. The treatment standards apply to all of the wastes generated in treating the original prohibited waste. Thus, all solids generated from treating these wastes would have to meet the treatment standard for nonwastewaters. All derived-from wastes meeting the Agency definition of wastewater (less than 1 percent TOC and less than 1 percent total filterable solids) would have to meet the treatment standard for wastewaters. EPA wishes to make clear that this approach is not meant to allow partial treatment in order to comply with the applicable standard.
3. The Agency has not performed tests, in all cases, on every waste that can result from every part of the treatment train. However, the Agency's treatment standards are based on treatment of the most concentrated form of the waste. Consequently, the Agency believes that the less concentrated wastes generated in the course of treatment will also be able to be treated to meet this value.

(2) Mixtures and other derived-from residues. There is a further question as to the applicability of the BDAT treatment standards to residues generated not from treating the waste (as discussed above), but from other types of management. Examples

are contaminated soil or leachate that is derived from managing the waste. In these cases, the mixture is still deemed to be the listed waste, either because of the derived-from rule (40 CFR Part 261.3(c)(2)(i)) or the mixture rule (40 CFR Part 261.3(a)(2)(iii) and (iv)) or because the listed waste is contained in the matrix (see, for example, 40 CFR Part 261.33(d)). The prohibition for the particular listed waste consequently applies to this type of waste.

The Agency believes that the majority of these types of residues can meet the treatment standards for the underlying listed wastes (with the possible exception of contaminated soil and debris for which the Agency is currently investigating whether it is appropriate to establish a separate treatability subcategorization). For the most part, these residues will be less concentrated than the original listed waste. The Agency's treatment standards also make a generous allowance for process variability by assuming that all treatability values used to establish the standard are lognormally distributed. The waste also might be amenable to a relatively nonvariable form of treatment technology such as incineration. Finally, and perhaps most important, the rules contain a treatability variance that allows a petitioner to demonstrate that its waste cannot be treated to the level specified in the rule (40 CFR Part 268.44(a)). This provision provides a safety valve that allows persons with unusual waste matrices to demonstrate the

appropriateness of a different standard. The Agency, to date, has not received any petitions under this provision (for example, for residues contaminated with a prohibited solvent waste), indicating, in the Agency's view, that the existing standards are generally achievable.

(3) Residues from managing listed wastes or that contain listed wastes. The Agency has been asked if and when residues from managing hazardous wastes, such as leachate and contaminated ground water, become subject to the land disposal prohibitions. Although the Agency believes this question to be settled by existing rules and interpretative statements, to avoid any possible confusion the Agency will address the question again.

Residues from managing First Third wastes, listed California List wastes, and spent solvent and dioxin wastes are all considered to be subject to the prohibitions for the underlying hazardous waste. Residues from managing California List wastes likewise are subject to the California List prohibitions when the residues themselves exhibit a characteristic of hazardous waste. This determination stems directly from the derived-from rule in 40 CFR Part 261.3(c)(2) or, in some cases, from the fact that the waste is mixed with or otherwise contains the listed waste. The underlying principle stated in all of these provisions is that listed wastes remain listed until delisted.



The Agency's historic practice in processing delisting petitions that address mixing residuals has been to consider them to be the listed waste and to require that delisting petitioners address all constituents for which the derived-from waste (or other mixed waste) was listed. The language in 40 CFR Part 260.22(b) states that mixtures or derived-from residues can be delisted provided a delisting petitioner makes a demonstration identical to that which a delisting petitioner would make for the underlying waste. Consequently, these residues are treated as the underlying listed waste for delisting purposes. The statute likewise takes this position, indicating that soil and debris that are contaminated with listed spent solvents or dioxin wastes are subject to the prohibition for these wastes even though these wastes are not the originally generated waste, but rather are a residual from management (RCRA section 3004(e)(3)). It is EPA's view that all such residues are covered by the existing prohibitions and treatment standards for the listed hazardous waste that these residues contain and from which they are derived.

#### 1.2.8 Transfer of Treatment Standards

EPA is proposing some treatment standards that are not based on testing of the treatment technology of the specific waste subject to the treatment standard. Instead, the Agency has determined that the constituents present in the subject waste can

be treated to the same performance levels as those observed in other wastes for which EPA has previously developed treatment data. EPA believes that transferring treatment performance for use in establishing treatment standards for untested wastes is technically valid in cases where the untested wastes are generated from similar industries, have similar processing steps, or have similar waste characteristics affecting performance and treatment selection. Transfer of treatment standards to similar wastes or wastes from similar processing steps requires little formal analysis. However, in a case where only the industry is similar, EPA more closely examines the waste characteristics prior to deciding whether the untested waste constituents can be treated to levels associated with tested wastes.

EPA undertakes a two-step analysis when determining whether wastes generated by different processes within a single industry can be treated to the same level of performance. First, EPA reviews the available waste characteristic data to identify those parameters that are expected to affect treatment selection. EPA has identified some of the most important constituents and other parameters needed to select the treatment technology appropriate for a given waste. A detailed discussion of each analysis, including how each parameter was selected for each waste, can be found in Section 5 of this document.

Second, when an individual analysis suggests that an untested waste can be treated with the same technology as a waste for which treatment performance data are already available, EPA analyzes a more detailed list of constituents that represent some of the most important waste characteristics that the Agency believes will affect the performance of the technology. By examining and comparing these characteristics, the Agency determines whether the untested wastes will achieve the same level of treatment as the tested waste. Where the Agency determines that the untested waste is easier to treat than the tested waste, the treatment standards can be transferred. A detailed discussion of this transfer process for each waste can be found in later sections of this document.

### 1.3 Variance from the BDAT Treatment Standard

The Agency recognizes that there may exist unique wastes that cannot be treated to the level specified as the treatment standard. In such a case, a generator or owner/operator may submit a petition to the Administrator requesting a variance from the treatment standard. A particular waste may be significantly different from the wastes considered in establishing treatability groups because the waste contains a more complex matrix that makes it more difficult to treat. For example, complex mixtures may be formed when a restricted waste is mixed with other waste streams by spills or other forms of inadvertent mixing. As a

result, the treatability of the restricted waste may be altered such that it cannot meet the applicable treatment standard.

Variance petitions must demonstrate that the treatment standard established for a given waste cannot be met. This demonstration can be made by showing that attempts to treat the waste by available technologies were not successful or by performing appropriate analyses of the waste, including waste characteristics affecting performance, which demonstrate that the waste cannot be treated to the specified levels. Variances will not be granted based solely on a showing that adequate BDAT treatment capacity is unavailable. (Such demonstrations can be made according to the provisions in Part 268.5 of RCRA for case-by-case extensions of the effective date.) The Agency will consider granting generic petitions provided that representative data are submitted to support a variance for each facility covered by the petition.

Petitioners should submit at least one copy to:

The Administrator  
U.S. Environmental Protection Agency  
401 M Street, S.W.  
Washington, DC 20460

An additional copy marked "Treatability Variance" should be submitted to:

Chief, Waste Treatment Branch  
Office of Solid Waste (WH-565)  
U.S. Environmental Protection Agency  
401 M Street, S.W.  
Washington, DC 20460

Petitions containing confidential information should be sent with only the inner envelope marked "Treatability Variance" and "Confidential Business Information" and with the contents marked in accordance with the requirements of 40 CFR Part 2 (41 FR 36902, September 1, 1976, amended by 43 FR 4000).

The petition should contain the following information:

1. The petitioner's name and address.
2. A statement of the petitioner's interest in the proposed action.
3. The name, address, and EPA identification number of the facility generating the waste, and the name and telephone number of the plant contact.
4. The process(es) and feed materials generating the waste and an assessment of whether such process(es) or feed materials may produce a waste that is not covered by the demonstration.
5. A description of the waste sufficient for comparison with the waste considered by the Agency in developing BDAT, and an estimate of the average and maximum monthly and annual quantities of waste covered by the demonstration. (Note: The petitioner should consult the appropriate BDAT background document for determining the characteristics of the wastes considered in developing treatment standards.)
6. If the waste has been treated, a description of the system used for treating the waste, including the process design and operating conditions. The petition should include the reasons the treatment standards are not achievable and/or why the petitioner believes the standards are based on inappropriate technology for treating the waste. (Note: The petitioner should refer to the BDAT background document as guidance for determining the design and operating parameters that the Agency used in developing treatment standards.)
7. A description of the alternative treatment systems examined by the petitioner (if any); a description of the treatment system deemed appropriate by the

petitioner for the waste in question; and, as appropriate, the concentrations in the treatment residual or extract of the treatment residual (i.e., using the TCLP, where appropriate, for stabilized metals) that can be achieved by applying such treatment to the waste.

8. A description of those parameters affecting treatment selection and waste characteristics that affect performance, including results of all analyses. (See Section 3.0 for a discussion of waste characteristics affecting performance that the Agency has identified for the technology representing BDAT.)
9. The dates of the sampling and testing.
10. A description of the methodologies and equipment used to obtain representative samples.
11. A description of the sample handling and preparation techniques, including techniques used for extraction, containerization, and preservation of the samples.
12. A description of analytical procedures used, including QA/QC methods.

After receiving a petition for a variance, the Administrator may request any additional information or waste samples that may be required to evaluate and process the petition. Additionally, all petitioners must certify that the information provided to the Agency is accurate under 40 CFR Part 268.4(b).

In determining whether a variance will be granted, the Agency will first look at the design and operation of the treatment system being used. If EPA determines that the technology and operation are consistent with BDAT, the Agency will evaluate the waste to determine if the waste matrix and/or physical parameters are such that the BDAT treatment standards reflect treatment of this waste. Essentially, this latter

analysis will concern the parameters affecting treatment selection and waste characteristics affecting performance parameters.

In cases where BDAT is based on more than one technology, the petitioner will need to demonstrate that the treatment standard cannot be met using any of the technologies, or that none of the technologies are appropriate for treatment of the waste. After the Agency has made a determination on the petition, the Agency's findings will be published in the Federal Register, followed by a 30-day period for public comment. After review of the public comments, EPA will publish its final determination in the Federal Register as an amendment to the treatment standards in 40 CFR Part 268, Subpart D.

## 2. INDUSTRY AFFECTED AND WASTE CHARACTERIZATION

The previous section provided the background for the Agency's study of K101 and K102 wastes. The purpose of this section is to describe the industry that will be affected by land disposal restrictions on waste codes K101 and K102, and to characterize these wastes. This section includes a description of the industry affected and the production processes employed in this industry. Also included is a discussion of how K101 and K102 wastes are generated by these processes. This section concludes with a characterization of the K101 and K102 wastes, and a determination of the waste treatability group for these wastes.

The full list of hazardous waste codes from specific sources is given in 40 CFR 261.32 (see discussion in Section 1 of this document). Within this list, two specific hazardous waste codes are generated by the veterinary pharmaceuticals industry.

K101: Distillation tar residues from the distillation of aniline-based compounds in the production of veterinary pharmaceuticals from arsenic or organo-arsenic compounds.

K102: Residue from the use of activated carbon for decolorization in the production of veterinary pharmaceuticals from arsenic or organo-arsenic compounds.

The Agency has determined that these waste codes (K101 and K102) represent a separate waste treatability group. This was



established because they originate from the same industry and similar processes: K102 in the production process and K101 in the treatment process of production wastewaters. In addition, the same treatment technologies apply to both waste codes. As a result, the Agency has examined the sources of the wastes, applicable treatment technologies, and treatment performance attainable in order to support a single regulatory approach for the two wastes.

## 2.1 Industry Affected and Process Description

The four digit standard industrial classification (SIC) code reported for the veterinary pharmaceuticals industry is 2834. The Agency has identified two facilities in the United States that are actively involved in the production of veterinary pharmaceuticals from arsenic or organo-arsenic compounds which could generate K101 and K102 wastes. Information from the listing background document and from facility contacts provides a geographic distribution of these facilities across the United States. The two facilities that are involved in producing arsenic based veterinary pharmaceuticals are located in northeast Iowa and southwest North Carolina.

The only process that EPA has identified that uses arsenic or organo-arsenic compounds is the production of 3-Nitro-4-Hydroxy-phenylarsonic acid (3-Nitro). The manufacture of

3-Nitro requires the reaction of an organic compound with inorganic arsenic to form the organo-arsenic product. The listed waste K102 is generated in the production process. Details of the production process are considered to be Confidential Business Information (CBI) and they are not presented here.<sup>1</sup> (See Figure 2-1).

The wastewaters and floor washings generated from 3-Nitro exhibit the characteristics of EP toxicity for arsenic. These wastewaters are EPA hazardous waste number D004.<sup>2</sup> In the treatment of the wastes from the production process, two listed wastes, K084 and K101, are generated (see Figure 2-2).

#### 2.1.1 Generation of K102 Waste

The product stream from the reactor in the 3-nitro-4-hydroxyphenylarsonic acid process goes to a hydrolysis tank where carbon and caustic soda are added to decolor the product stream. The decolorized stream from the hydrolysis tank is filtered in a filter press. The spent carbon removed is the listed waste K102. The filtrate from the filtering step undergoes additional steps and the product, 3-nitro-4-hydroxyphenylarsonic acid, is recovered. (See Figure 2-1).

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1. Details of the production of 3-Nitro are in the RCRA CBI Docket.
  2. Throughout the remainder of this document, this characteristic waste will be referred to simply as D004.

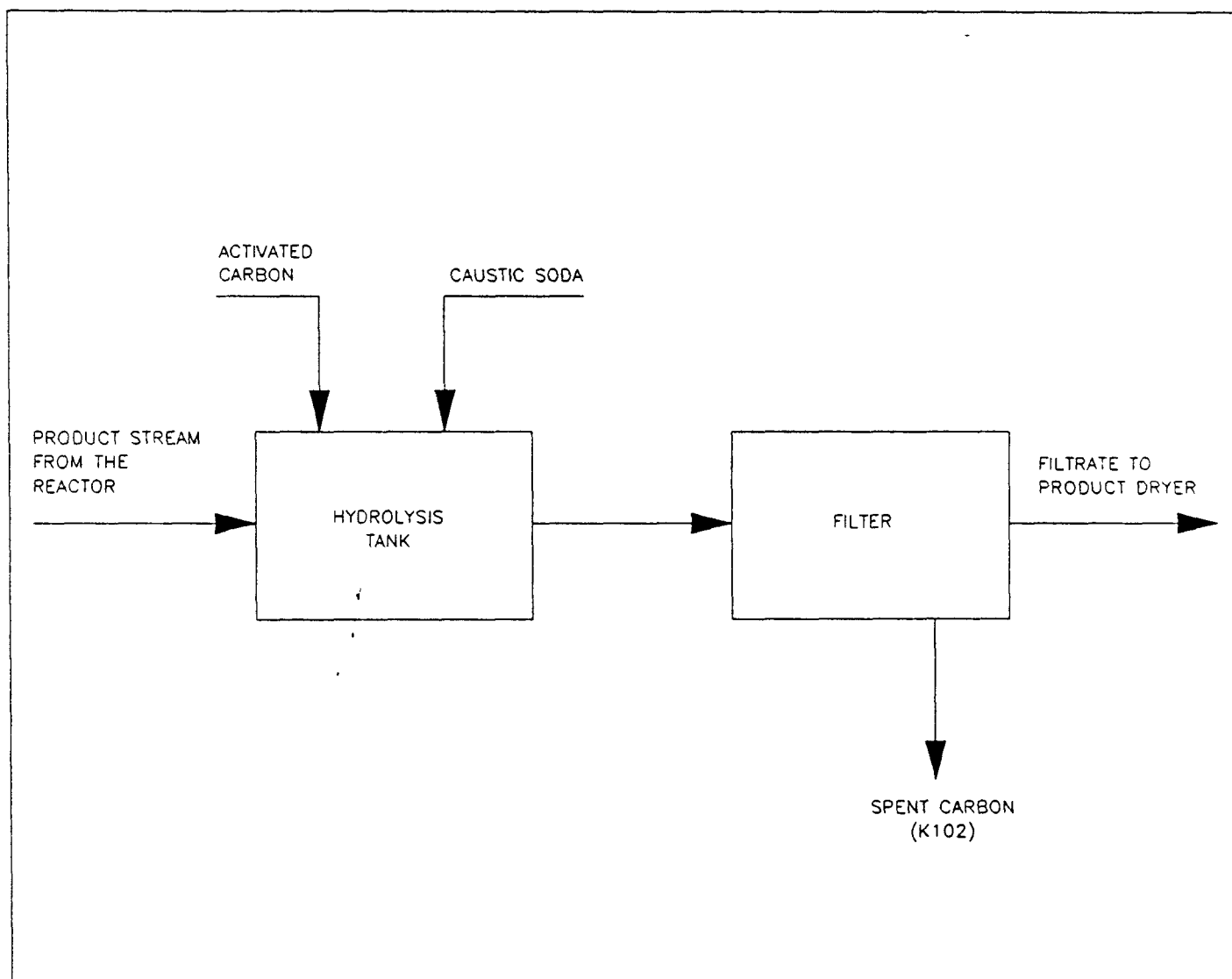


FIGURE 2-1

GENERATION OF K102 FROM 3-NITRO 4-HYDROXYPHENYLARSONIC  
ACID PRODUCTION

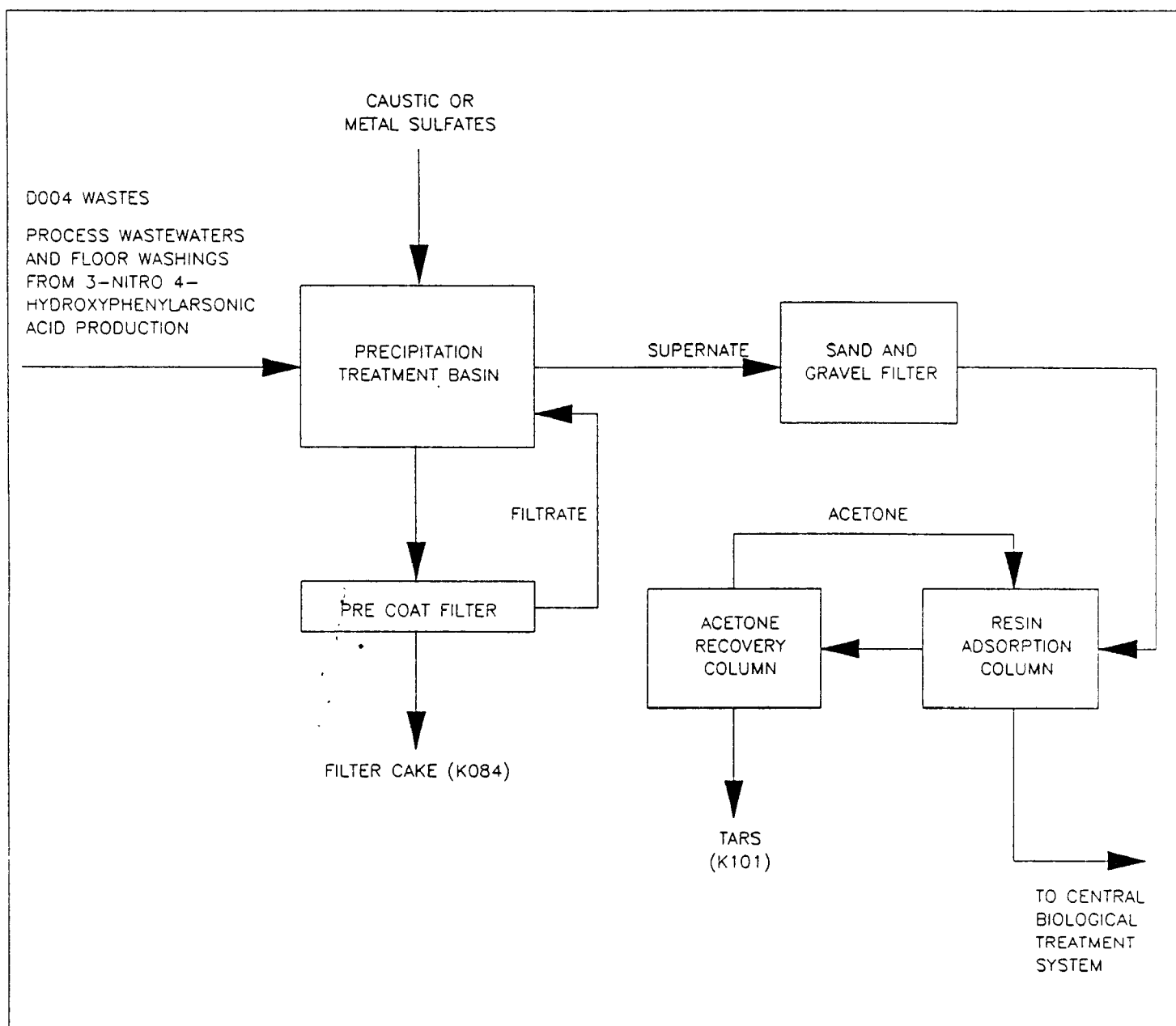


FIGURE 2-2

GENERATION OF K084 AND K101 FROM THE TREATMENT  
OF D004 WASTES

### 2.1.2 Generation of K101 Waste

The listed waste K101 is generated in the treatment of wastewaters originating from the production of arsenic-containing veterinary pharmaceuticals (See Figure 2-2). The wastewaters, D004, are treated in a series of steps. First, the wastewaters are precipitated using caustic and metal sulfates. The precipitated salts generated are the listed waste K084. Secondly, the supernate from the chemical precipitation step passes through a sand and gravel filter to remove undissolved solids. Thirdly, the filtered supernate passes through a resin adsorption column designed to remove ortho-nitroanilines (2-nitroaniline) and ortho-nitrophenol (2-nitrophenol). The resin adsorption column is regenerated with acetone. The acetone used for this regeneration is distilled in an acetone recovery column. The clay-like tars generated in the distillation are the listed waste K101.

### 2.2 Waste Characterization

This section includes all waste characterization data available to the Agency for the K101 and K102 wastes. An estimate of the major constituents in these wastes and their approximate concentrations are presented in Table 2-1. The percent concentration of each major constituent in the wastes was determined from best estimates based on chemical analyses.

Table 2-1 shows that the major constituent of K101 is the clay-like tar from the acetone recovery column (78 percent). BDAT list organics and metals each are present in less than 1 percent in K101. The non-BDAT list organic, 2-nitroaniline accounts for 20 percent of K101 waste. The major constituent present in K102 is spent activated carbon (97 percent). BDAT organics account for less than 1 percent of the K102 waste. BDAT metals are present in K102 at less than 2 percent with arsenic and antimony being the majority of metals present.

The ranges of BDAT constituents present in each waste and all other available data concerning waste characterization parameters, obtained from the Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, are presented by waste code in Table 2-2. This table lists the ranges of BDAT organics (volatile and semivolatile), metals, and inorganics other than metals present in K101 and K102 wastes. Other parameters analyzed in the wastes include non-BDAT organics, chlorides, sulfates, total solids, total suspended solids, total dissolved solids, and total organic carbon.

### 2.3 Determination of Waste Treatability Group

Fundamental to waste treatment is the concept that the type of treatment technology used and the level of treatment achieved depend on the physical and chemical characteristics of the waste.

Table 2-1

## Major Constituent Composition for K101 Waste\*

Constituent	Weight Percent in K101
BDAT Organics	<1
BDAT Metals	<1
2-Nitroaniline	<20
Clay-like tar	<u>&gt;78</u>
	100%

## Major Constituent Composition for K102 Waste\*

Constituent	Weight Percent in K102
BDAT Organics	<1
Arsenic	<1
Other BDAT Metals (primarily antimony)	<1
Spent Activated Carbon	<u>&gt;97</u>
	100%

\* - Percent concentrations presented here were determined from best estimates based on chemical analyses.

Reference: Onsite Engineering Reports for John Zink Company, Tulsa, Oklahoma, for waste codes K101 and K102, p. 10 and p. 11, respectively.

TABLE 2-2 BDAT CONSTITUENT ANALYSIS AND OTHER DATA FOR WASTE CODES K101 AND K102 <sup>a</sup>

	Untreated K101 Waste Concentration Ranges (mg/kg)	Untreated K102 Waste Concentration Ranges (mg/kg)
BDAT		
<u>Volatile Organics</u>		
222 Acetone	<50 - 81	ND
43 Toluene	<25 - 42	5.4 - 26
215-217 Total Xylenes	ND	<1.5 - 5.3
<u>Semivolatile Organics</u>		
70 Bis(2-ethylhexyl)Phthalate	<36,000 - <38,000	<19.4 - <194
142 Phenol	ND	<19.4 - <194
<u>Metals</u>		
154 Antimony	<3.3 - 7.4	8,960 - 18,800
155 Arsenic	590 - 1,950	3,060 - 8,320
156 Barium	3.5 - 108	16 - 52
157 Beryllium	<0.1	<0.10 - 0.20
158 Cadmium	<5.0	8.9 - 26
159 Chromium	2.0 - 22	16 - 22
160 Copper	128 - 289	4.7 - 6.6
161 Lead	<0.5 - 6.7	1.6 - 25.9
162 Mercury	1.5 - 4.2	<0.1 - 3.5
163 Nickel	1.8 - 5.4	<1.1 - 13
164 Selenium	<0.5	9.1 - 17
165 Silver	<0.7 - 1.6	<0.7
166 Thallium	<5.0	<1.0 - 2.1
167 Vanadium	<0.4 - 1.7	<0.40 - 0.58
168 Zinc	35 - 111	3.1 - 8.7
<u>Inorganics</u>		
169 Cyanide	<0.67	3.21 - 5.06
170 Flouride	7.74**	4.35**
171 Sulfide	65.6 - 778	4,250 - 8,150
NON-BDAT		
* 2-Nitroaniline	<172,000 - 191,000	ND
* 2-Nitrophenol	ND	220 - 870
Chlorides	9,960 - 38,700	336 - 7,080
Sulfate	5,690 - 11,800	37 - 338
Total Solids	604,000 - 804,000	333,000 - 395,000
Total Suspended Solids	NA	NA
Total Dissolved Solids	NA	NA
Total Organic Carbon	254,900 - 407,400	163,100 - 216,500

a - Obtained from Onsite Engineering Report, John Zink Company, Tulsa, Oklahoma, for K101 and K102. Tables 5-3 through 5-6 and 5-3 through 5-8, respectively.

\* - This constituent is not on the list of constituents in the GENERIC QUALITY ASSURANCE PROJECT PLAN FOR LAND DISPOSAL RESTRICTIONS PROGRAM ("BDAT"), EPA/530-SW-87-011, March 1987. It is a groundwater monitoring constituent as listed in Appendix IX, 40 CFR Part 264, 51 FR 26639, July 24, 1986.

\*\* - This constituent was analyzed in only one sample set.

NA - Not analyzed.

ND - Not detected.



In cases where EPA believes that wastes represented by different codes can be treated to similar concentrations using the same technologies, the Agency combines the codes into one treatability group. In particular, the two listed wastes K101 and K102, from the production of veterinary pharmaceuticals were combined into a single waste treatability group.

The listed wastes K101 and K102 are considered to be one treatability group for the following reasons. First, these two wastes are produced in the veterinary pharmaceutical industry and are generated in related processes. Second, the two wastes have similar chemical characteristics including: high total organic carbon, relatively low levels of BDAT metals and inorganics, and low filterable solids content. For these reasons, the Agency believes that the K101 and K102 wastes represent a separate waste treatability group.

### 3. APPLICABLE/DEMONSTRATED TREATMENT TECHNOLOGIES

The purpose of this section is to describe applicable treatment technologies for treatment of K101 and K102 wastes that the Agency has identified as applicable and to describe which of the applicable technologies the Agency has determined to be demonstrated. Included in this section are discussions of those applicable treatment technologies that have been demonstrated on a commercial basis. The technologies which were considered to be applicable are those which treat organic compounds by concentration reduction. Also, this section describes the performance data available for these technologies.

The previous section described the industry that will be affected by restrictions on the K102 waste, and presented a characterization of this waste. Characterization of the K102 waste indicates that this waste primarily consists of spent activated carbon (greater than 97 percent), BDAT list organics (less than 1 percent), and BDAT list metals (less than 2 percent). Analyses of K101 waste indicates that this waste primarily consists of 2-nitroaniline (less than 20 percent), a clay-like tar (greater than 78 percent), BDAT list organics (less than 1 percent), and BDAT list metals (less than 1 percent). The Agency has identified these treatment technologies which may be applicable to K101 and K102 because the technologies are designed to reduce the concentration of organic compounds present in the

untreated waste. The selection of the treatment technologies applicable for treating organic compounds in K101 and K102 wastes is based on information obtained from engineering site visits and available literature sources.

### 3.1 Applicable Treatment Technologies

For K101 and K102 nonwastewater, the Agency has identified the following treatment technologies as being applicable: rotary kiln incineration (which thermally destroys organic components in the waste) followed by metals stabilization of the resulting kiln ash (which reduces leachability of metal components by binding the metals to the solid matrix).

For K101 and K102 wastewaters, namely the scrubber waters generated from treatment by rotary kiln incineration, the Agency has identified the following treatment technology as being applicable: chemical precipitation (which removes dissolved metals by addition of a treatment chemical to form a metal precipitate).

Chemical precipitation of the scrubber waters generates a residual. The precipitated metals represent an inorganic form of the nonwastewaters. The kiln ash is also an inorganic form of K101 and K102 nonwastewaters and the applicable treatment technology is metals stabilization. Therefore, the applicable

technology for chemical precipitated residuals from scrubber waters is metals stabilization.

### 3.2 Demonstrated Treatment Technologies

#### i. Nonwastewaters

The current treatment practices for wastes K101 and K102 in the veterinary pharmaceutical industry is incineration followed by land disposal, and stabilization followed by land disposal. The Agency, therefore, believes that incineration and stabilization are applicable for treating K101 and K102 waste. However, the Agency does not believe that either incineration or stabilization alone is the best treatment for waste K101 and K102.

The Agency believes that rotary kiln incineration of organic nonwastewaters and metals stabilization of inorganic nonwastewaters is demonstrated for K101 and K102 because these technologies have been used on a commercial basis to treat wastes similar to K101 and K102. The Agency has performance data for incineration treatment for K101 and K102 organic nonwastewaters. However, the Agency did not collect performance data for metals stabilization of the inorganic K101 and K102 nonwastewaters.

## ii. Wastewaters

Chemical precipitation has not been demonstrated for K101 and K102 wastewaters. Chemical precipitation has been demonstrated in wastewaters similar to those from K101 and K102 with regards to parameters affecting treatment selection. Therefore, the Agency has determined that chemical precipitation of wastewaters is demonstrated. However, the Agency did not collect performance data for chemical precipitation of K101 and K102 wastewaters.

### 3.3 Detailed Description of Treatment Technologies

A more detailed discussion of the treatment technology system for which the Agency has collected performance data is presented in Sections 3.3.1, 3.3.2 and 3.3.3.

#### 3.3.1 Incineration

This section addresses the commonly used incineration technologies: liquid injection, rotary kiln, fluidized bed incineration, and fixed hearth. A discussion is provided regarding the applicability of these technologies, the underlying principles of operation, a technology description, waste characteristics that affect performance, and finally important design and operating parameters. As appropriate the subsections are divided by type of incineration unit.

(1) Applicability and Use of this Technology

i. Liquid Injection

Liquid injection is applicable to wastes that have viscosity values sufficiently low so that the waste can be atomized in the combustion chamber. A range of literature maximum viscosity values are reported with the low being 100 SSU and the high being 10,000 SSU. It is important to note that viscosity is temperature dependent so that while liquid injection may not be applicable to a waste at ambient conditions, it may be applicable when the waste is heated. Other factors that affect the use of liquid injection are particle size and the presence of suspended solids. Both of these waste parameters can cause plugging of the burner nozzle.

ii. Rotary Kiln/ Fluidized Bed/ Fixed Hearth

These incineration technologies are applicable to a wide range of hazardous wastes. They can be used on wastes that contain high or low total organic content, high or low filterable solids, various viscosity ranges, and a range of other waste parameters. EPA has not found these technologies to be demonstrated on wastes that are comprised essentially of metals with low organic concentrations. In addition, the Agency expects that some of the high metal content wastes may not be compatible with existing and future air emission limits without emission controls far more extensive than currently practiced.

## (2) Underlying Principles of Operation

### i. Liquid Injection

The basic operating principle of this incineration technology is that incoming liquid wastes are volatilized and then additional heat is supplied to the waste to destabilize the chemical bonds. Once the chemical bonds are broken, these constituents react with oxygen to form carbon dioxide and water vapor. The energy needed to destabilize the bonds is referred to as the energy of activation.

### ii. Rotary Kiln and Fixed Hearth

There are two distinct principles of operation for these incineration technologies, one for each of the chambers involved. In the primary chamber, energy, in the form of heat, is transferred to the waste to achieve volatilization of the various organic waste constituents. During this volatilization process some of the organic constituents will oxidize to  $\text{CO}_2$  and water vapor. In the secondary chamber, additional heat is supplied to overcome the energy requirements needed to destabilize the chemical bonds and allow the constituents to react with excess oxygen to form carbon dioxide and water vapor. The principle of operation for the secondary chamber is similar to liquid injection.

### iii. Fluidized Bed

The principle of operation for this incinerator technology is somewhat different than for rotary kiln and fixed hearth incineration relative to the functions of the primary and secondary chambers. In fluidized bed, the purpose of the primary chamber is not only to volatilize the wastes but also to essentially combust the waste. Destruction of the waste organics can be accomplished to a better degree in the primary chamber of this technology than for rotary kiln and fixed hearth because of 1) improved heat transfer from fluidization of the waste using forced air and 2) the fact that the fluidization process provides sufficient oxygen and turbulence to convert the organics to carbon dioxide and water vapor. The secondary chamber (referred to as the freeboard) generally does not have an afterburner; however, additional time is provided for conversion of the organic constituents to carbon dioxide, water vapor, and hydrochloric acid if chlorine is present in the waste.

## (3) Description of Incineration Technologies

### i. Liquid Injection

The liquid injection system is capable of incinerating a wide range of gases and liquids. The combustion system has a simple design with virtually no moving parts. A burner or nozzle atomizes the liquid waste and injects it into the combustion chamber where it burns in the presence of air or oxygen. A



forced draft system supplies the combustion chamber with air to provide oxygen for combustion and turbulence for mixing. The combustion chamber is usually a cylinder lined with refractory (i.e., heat resistant) brick and can be fired horizontally, vertically upward, or vertically downward. Figure 3-1 illustrates a liquid injection incineration system.

#### ii. Rotary Kiln

A rotary kiln is a slowly rotating, refractory-lined cylinder that is mounted at a slight incline from the horizontal (see Figure 3-2). Solid wastes enter at the high end of the kiln, and liquid or gaseous wastes enter through atomizing nozzles in the kiln or afterburner section. Rotation of the kiln exposes the solids to the heat, vaporizes them, and allows them to combust by mixing with air. The rotation also causes the ash to move to the lower end of the kiln where it can be removed. Rotary kiln systems usually have a secondary combustion chamber or afterburner following the kiln for further combustion of the volatilized components of solid wastes.

#### iii. Fluidized Bed

A fluidized bed incinerator consists of a column containing inert particles such as sand which is referred to as the bed. Air, driven by a blower, enters the bottom of the bed to fluidize the sand. Air passage through the bed promotes rapid and uniform mixing of the injected waste material within the fluidized bed.

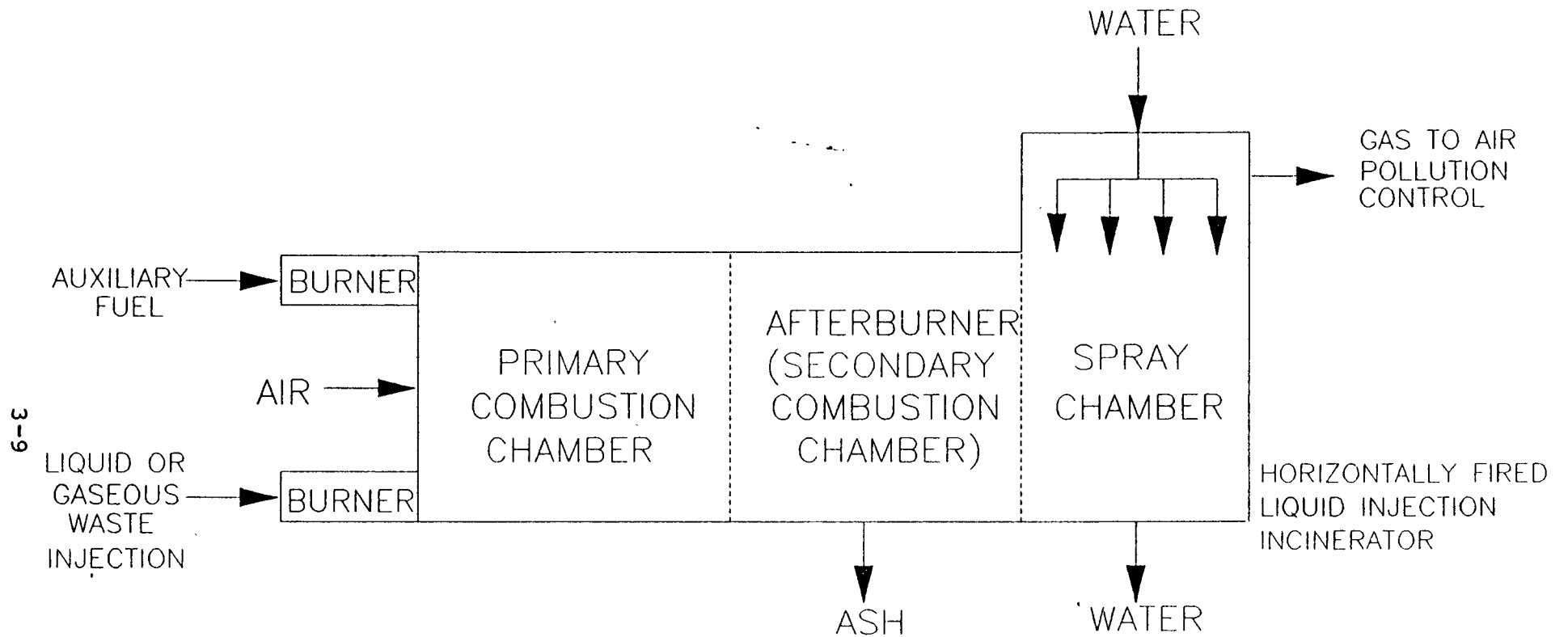


FIGURE 3-1  
LIQUID INJECTION INCINERATOR

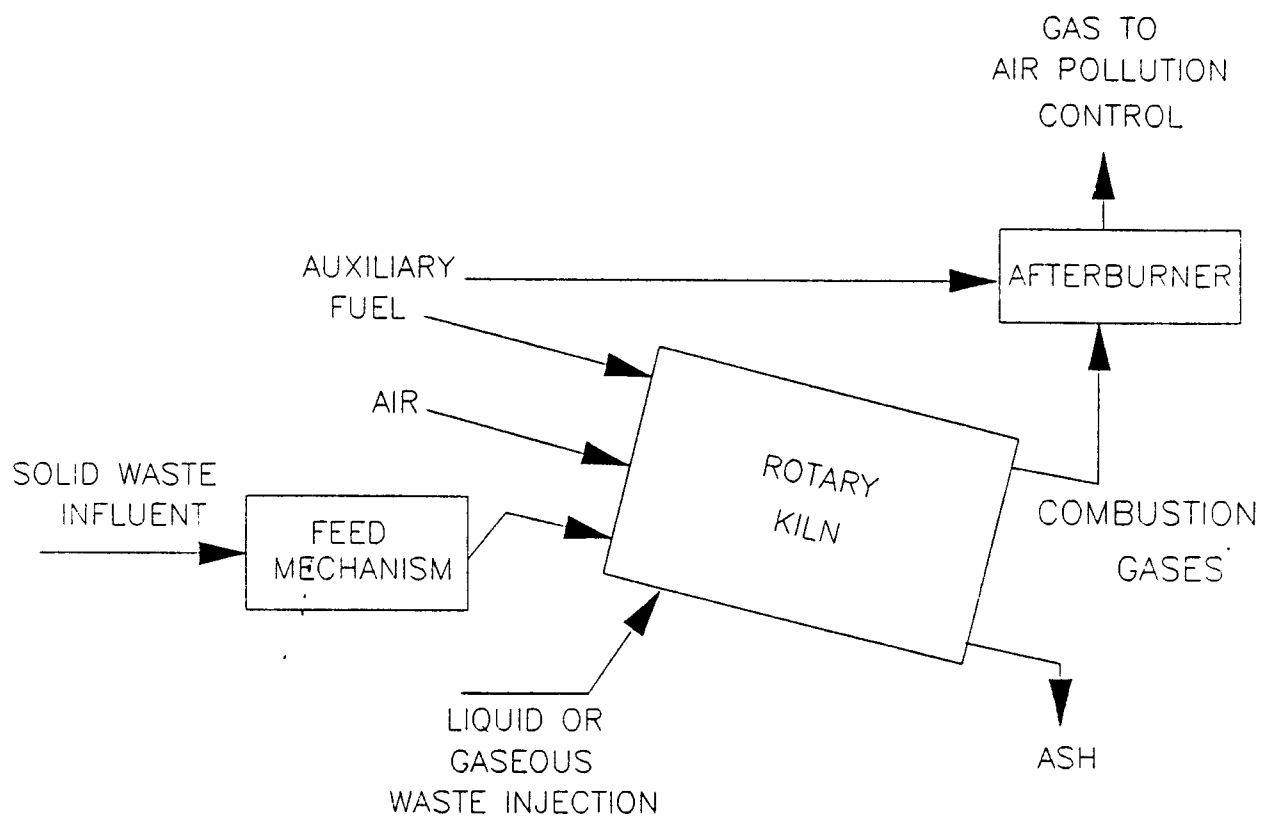


FIGURE 3-2 ROTARY KILN INCINERATOR

The fluidized bed has an extremely high heat capacity (approximately three times that of flue gas at the same temperature), thereby providing a large heat reservoir. The injected waste reaches ignition temperature quickly and transfers the heat of combustion back to the bed. Continued bed agitation by the fluidizing air allows larger particles to remain suspended in the combustion zone. (See Figure 3-3).

#### iv. Fixed Hearth Incineration

Fixed hearth incinerators, also called controlled air or starved air incinerators, are another major technology used for hazardous waste incineration. Fixed hearth incineration is a two-stage combustion process (see Figure 3-4). Waste is ram-fed into the first stage, or primary chamber, and burned at less than stoichiometric conditions. The resultant smoke and pyrolysis products, consisting primarily of volatile hydrocarbons and carbon monoxide, along with the normal products of combustion, pass to the secondary chamber. Here, additional air is injected to complete the combustion. This two-stage process generally yields low stack particulate and carbon monoxide (CO) emissions. The primary chamber combustion reactions and combustion gas are maintained at low levels by the starved air conditions so that particulate entrainment and carryover are minimized.

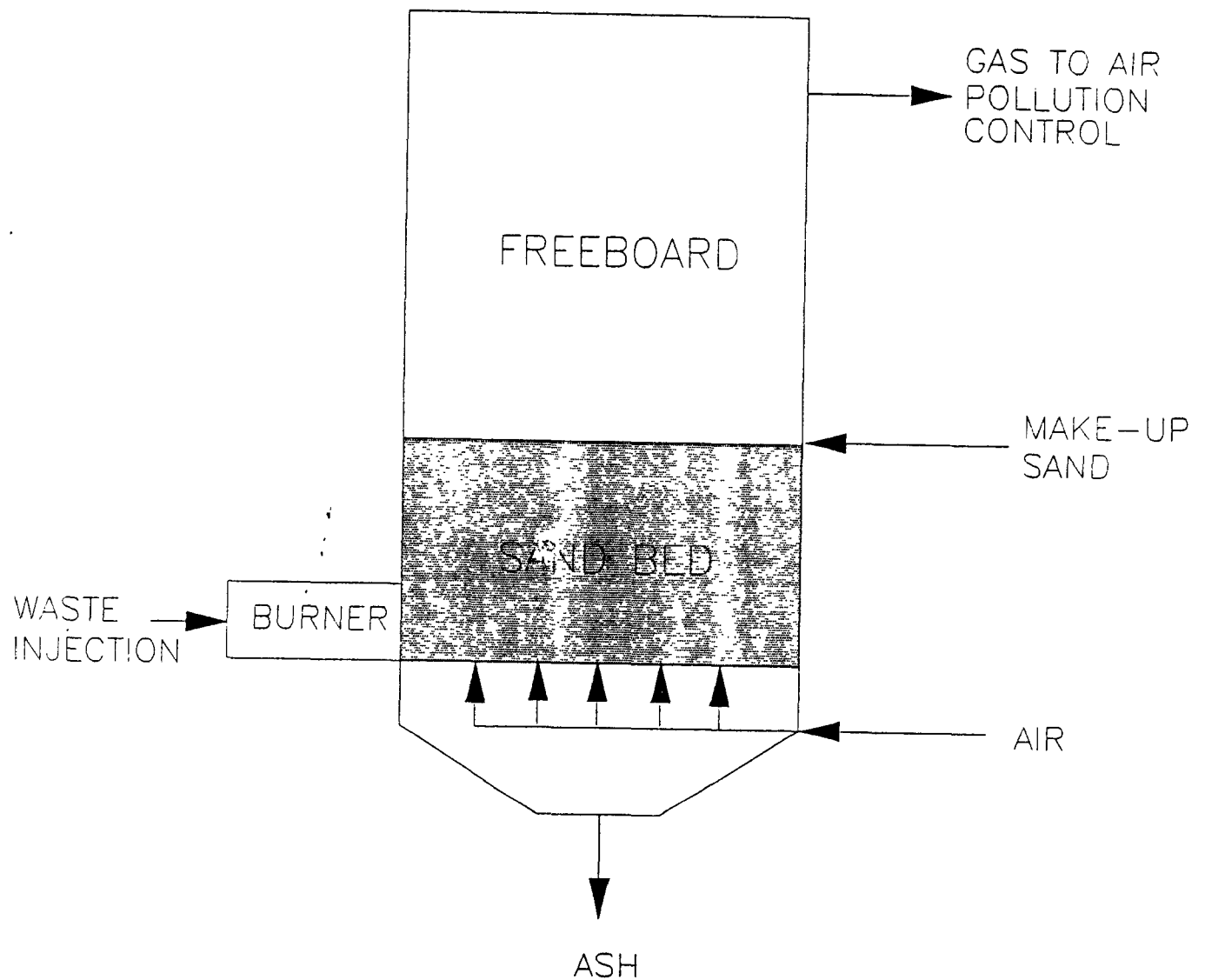


FIGURE 3-3  
FLUIDIZED BED INCINERATOR

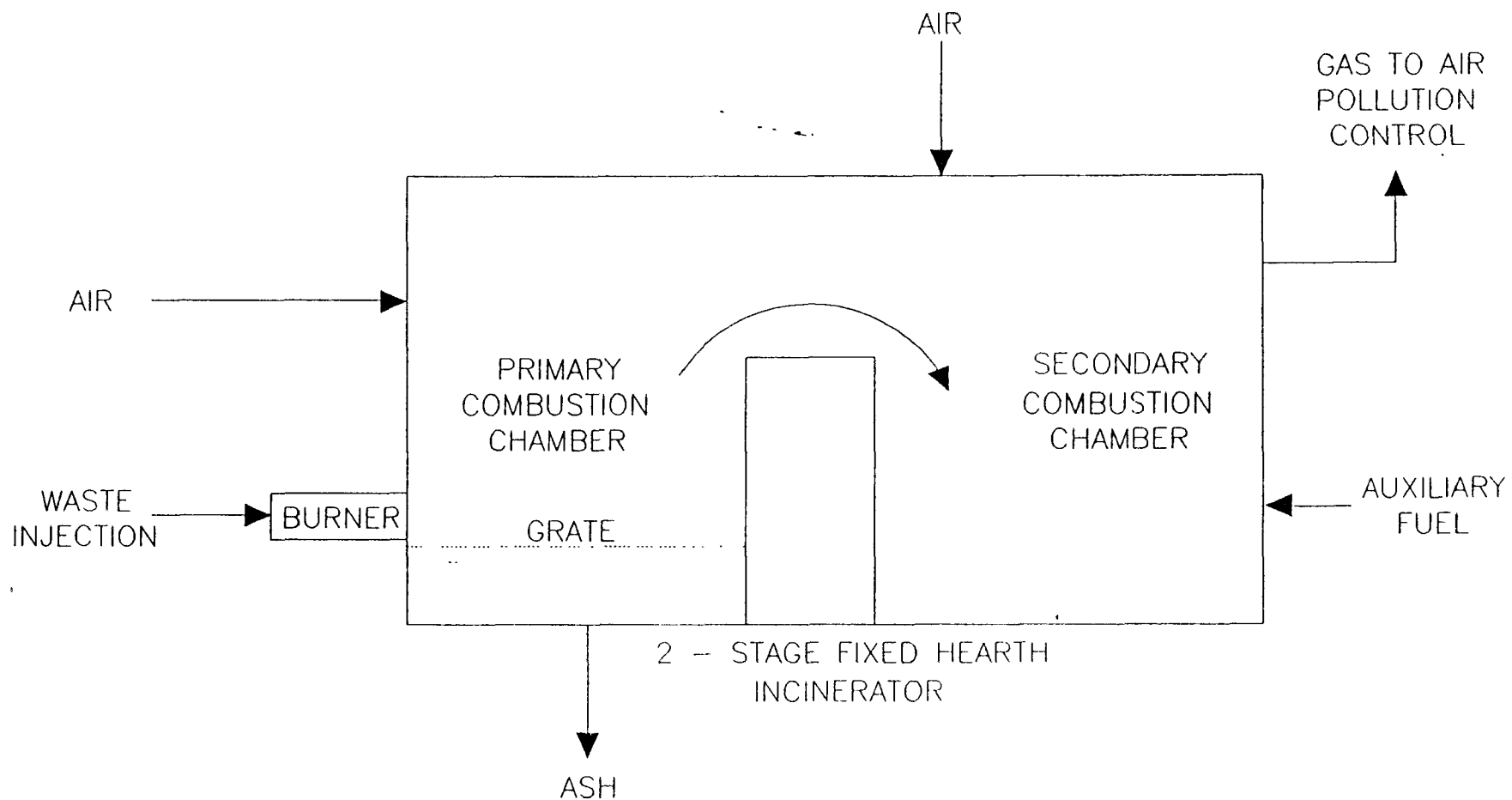


FIGURE 3-4 FIXED HEARTH INCINERATOR

#### v. Air Pollution Controls

Following incineration of hazardous wastes, combustion gases are generally further treated in an air pollution control system. The presence of chlorine or other halogens in the waste requires a scrubbing or absorption step to remove HCl and other halo-acids from the combustion gases. Ash in the waste is not destroyed in the combustion process. Depending on its composition, ash will either exit as bottom ash, at the discharge end of a kiln or hearth for example, or as particulate matter (fly ash) suspended in the combustion gas stream. Particulate emissions from most hazardous waste combustion systems generally have particle diameters less than one micron and require high efficiency collection devices to minimize air emissions. In addition, scrubber systems provide additional buffer against accidental releases of incompletely destroyed waste products due to poor combustion efficiency or combustion upsets, such as flame outs.

#### (4) Waste Characteristics Affecting Performance (WCAP)

##### i. Liquid Injection

In determining whether liquid injection is likely to achieve the same level of performance on an untested waste as a previously tested waste, the Agency will compare dissociation bond energies of the constituents in the untested and tested waste. This parameter is being used as a surrogate indicator of

activation energy which, as discussed previously, destabilizes molecular bonds. In theory, the bond dissociation energy would be equal to the activation energy; however, in practice this is not always the case. Other energy effects (e.g., vibrational, the formation of intermediates, and interactions between different molecular bonds) may have a significant influence on activation energy.

Because of the shortcomings of bond energies in estimating activation energy, EPA analyzed other waste characteristic parameters to determine if these parameters would provide a better basis for transferring treatment standards from an untested waste to a tested waste. These parameters include heat of combustion, heat of formation, use of available kinetic data to predict activation energies, and general structural class. All of these were rejected for reasons provided below.

The heat of combustion only measures the difference in energy of the products and reactants; it does not provide information on the transition state (i.e., the energy input needed to initiate the reaction). Heat of formation is used as a predictive tool for whether reactions are likely to proceed; however, there are a significant number of hazardous constituents for which these data are not available. Use of kinetic data were rejected because these data are limited and could not be used to calculate free energy values ( $\Delta G$ ) for the wide range of



hazardous constituents to be addressed by this rule. Finally, EPA decided not to use structural classes because the Agency believes that evaluation of bond dissociation energies allows for a more direct determination of whether a constituent will be destabilized.

ii. Rotary Kiln/Fluidized Bed/Fixed Hearth

Unlike liquid injection, these incineration technologies also generate a residual ash. Accordingly, in determining whether these technologies are likely to achieve the same level of performance on an untested waste as a previously tested waste, EPA would need to examine the waste characteristics that affect volatilization, of organics from the waste, as well as, destruction of the organics, once volatilized. Relative to volatilization, EPA will examine thermal conductivity of the entire waste and boiling point of the various constituents. As with liquid injection, EPA will examine bond energies in determining whether treatment standards for scrubber water residuals can be transferred from a tested waste to an untested waste. Below is a discussion of how EPA arrived at thermal conductivity and boiling point as the best method to assess volatilization of organics from the waste; the discussion relative to bond energies is the same for these technologies as for liquid injection and will not be repeated here.

### Thermal Conductivity

Consistent with the underlying principles of incineration, a major factor with regard to whether a particular constituent will volatilize is the transfer of heat through the waste. In the case of rotary kiln, fluidized bed, and fixed hearth incineration, heat is transferred through the waste by three mechanisms: radiation, convection, and conduction. For a given incinerator, heat transferred through various wastes by radiation is more a function of the design and type of incinerator than the waste being treated. Accordingly, the type of waste treated will have a minimal impact on the amount of heat transferred by radiation. With regard to convection, EPA also believes that the type of heat transfer will generally be more a function of the type and design of incinerator than the waste itself. However, EPA is examining particle size as a waste characteristic that may significantly impact the amount of heat transferred to a waste by convection and thus impact volatilization of the various organic compounds. The final type of heat transfer, conduction, is the one that EPA believes will have the greatest impact on volatilization of organic constituents. To measure this characteristic, EPA will use thermal conductivity; an explanation of this parameter, as well as, how it can be measured is provided below.

Heat flow by conduction is proportional to the temperature gradient across the material. The proportionality constant is a property of the material and referred to as the thermal conductivity. (Note: The analytical method that EPA has identified for measurement of thermal conductivity is named "Guarded, Comparative, Longitudinal Heat Flow Technique"; it is described in Appendix E.) In theory, thermal conductivity would always provide a good indication of whether a constituent in an untested waste would be treated to the same extent in the primary incinerator chamber as the same constituent in a previously tested waste.

In practice, thermal conductivity has some limitations in assessing the transferability of treatment standards; however, EPA has not identified a parameter that can provide a better indication of heat transfer characteristics of a waste. Below is a discussion of both the limitations associated with thermal conductivity, as well as other parameters considered.

Thermal conductivity measurements, as part of a treatability comparison for two different wastes through a single incinerator, are most meaningful when applied to wastes that are homogeneous (i.e., major constituents are essentially the same). As wastes exhibit greater degrees of non-homogeneity (e.g., significant concentration of metals in soil), then thermal conductivity becomes less accurate in predicting treatability because the

measurement essentially reflects heat flow through regions having the greatest conductivity (i.e., the path of least resistance) and not heat flow through all parts of the waste.

The thermal conductivities for the listed wastes, K101 and K102, were determined by the "Guarded, Comparative, Longitudinal Heat Flow Technique." This method and the results for K101 and K102 are discussed in Appendix E. The thermal conductivities for K101 and K102 were determined to be 0.273 W/mK and 0.136 W/mK, respectively.

BTU value, specific heat, and ash content were also considered for predicting heat transfer characteristics. These parameters can no better account for non-homogeneity than thermal conductivity; additionally, they are not directly related to heat transfer characteristics. Therefore, these parameters do not provide a better indication of heat transfer that will occur in any specific waste.

#### Boiling Point

Once heat is transferred to a constituent within a waste, then removal of this constituent from the waste will depend on its volatility. As a surrogate of volatility, EPA is using boiling point of the constituent. Compounds with lower boiling points have higher vapor pressures and, therefore, would be more

likely to vaporize. The Agency recognizes that this parameter does not take into consideration the impact of other compounds in the waste on the boiling point of a constituent in a mixture; however, the Agency is not aware of a better measure of volatility that can easily be determined. The boiling points for 2-nitroaniline and 2-nitrophenol are 284°C and 216°C, respectively.

#### (5) Incineration Design and Operating Parameters

##### i. Liquid Injection

For a liquid injection unit, EPA's analysis of whether the unit is well designed will focus on (1) the likelihood that sufficient energy is provided to the waste to overcome the activation level for breaking molecular bonds and (2) whether sufficient oxygen is present to convert the waste constituents to carbon dioxide and water vapor. The specific design parameters that the Agency will evaluate to assess whether these conditions are met are: temperature, excess oxygen, and residence time. Below is a discussion of why EPA believes these parameters to be important, as well as a discussion of how these parameters will be monitored during operation.

It is important to point out that, relative to the development of land disposed restriction standards, EPA is only concerned with these design parameters when a quench water or

scrubber water residual is generated from treatment of a particular waste. If treatment of a particular waste in a liquid injection unit would not generate a wastewater stream, then the Agency, for purposes of land disposal treatment standards, would only be concerned with the waste characteristics that affect selection of the unit, not the above-mentioned design parameters.

### Temperature

Temperature is important in that it provides an indirect measure of the energy available (i.e., BTUs/hr) to overcome the activation energy of waste constituents. As the design temperature increases, the more likely it is that the molecular bonds will be destabilized and the reaction completed.

The temperature is normally controlled automatically through the use of instrumentation which senses the temperature and automatically adjusts the amount of fuel and/or waste being fed. The temperature signal transmitted to the controller can be simultaneously transmitted to a recording device, referred to as a strip chart, and thereby continuously recorded. To fully assess the operation of the unit, it is important to know not only the exact location in the incinerator that the temperature is being monitored but also the location of the design temperature.

### Excess Oxygen

It is important that the incinerator contain oxygen in excess of the stoichiometric amount necessary to convert the organic compounds to carbon dioxide and water vapor. If insufficient oxygen is present, then destabilized waste constituents could recombine to the same or other BDAT list organic compounds and potentially cause the scrubber water to contain higher concentrations of BDAT list constituents than would be the case for a well operated unit.

In practice, the amount of oxygen fed to the incinerator is controlled by continuous sampling and analysis of the stack gas. If the amount of oxygen drops below the design value, then the analyzer transmits a signal to the valve controlling the air supply and thereby increases the flow of oxygen to the afterburner. The analyzer simultaneously transmits a signal to a recording device so that the amount of excess oxygen can be continuously recorded. Again, as with temperature, it is important to know the location from which the combustion gas is being sampled.

### Carbon Monoxide

Carbon monoxide is an important operating parameter because it provides an indication of the extent to which the waste

organic constituents are being converted to CO<sub>2</sub> and water vapor. As the carbon monoxide level increases, it indicates that greater amounts of organic waste constituents are unreacted or partially reacted. Increased carbon monoxide levels can result from insufficient excess oxygen, insufficient turbulence in the combustion zone, or insufficient residence time.

#### Waste Feed Rate

The waste feed rate is important to monitor because it is correlated to the residence time. The residence time is associated with a specific Btu energy value of the feed and a specific volume of combustion gas generated. Prior to incineration, the BTU value of the waste is determined through the use of a laboratory device known as a bomb calorimeter. The volume of combustion gas generated from the waste to be incinerated is determined from an analysis referred to as an ultimate analysis. This analysis determines the amount of elemental constituents present which include carbon, hydrogen, sulfur, oxygen, nitrogen, and halogens. Using this analysis plus the total amount of air added, the volume of combustion gas can be calculated. Having determined both the BTU content and the expected combustion gas volume, the feed rate can be fixed at the desired residence time. Continuous monitoring of the feed rate will determine whether the unit was operated at a rate corresponding to the designed residence time.



## ii. Rotary Kiln

For this incineration, EPA will examine both the primary and secondary chamber in evaluating the design of a particular incinerator. Relative to the primary chamber, EPA's assessment of design will focus on whether it is likely that sufficient energy will be provided to the waste in order to volatilize the waste constituents. For the secondary chamber, analogous to the sole liquid injection incineration chamber, EPA will examine the same parameters discussed previously under liquid injection incineration. These parameters will not be discussed again here.

The particular design parameters to be evaluated for the primary chamber are: kiln temperature, residence time, and revolutions per minute. Below is a discussion of why EPA believes these parameters to be important, as well as a discussion of how these parameters will be monitored during operation.

### Temperature

The primary chamber temperature is important, in that it provides an indirect measure of the energy input (i.e., BTUs/hr) that is available for heating the waste. The higher the temperature is designed to be in a given kiln, the more likely it is that the constituents will volatilize. As discussed earlier

under "Liquid Injection", temperature should be continuously monitored and recorded. Additionally, it is important to know the location of the temperature sensing device in the kiln.

### Residence Time

This parameter is important in that it affects whether sufficient heat is transferred to a particular constituent in order for volatilization to occur. As the time that the waste is in the kiln is increased, a greater quantity of heat is transferred to the hazardous waste constituents. The residence time will be a function of the specific configuration of the rotary kiln including the length and diameter of the kiln, the waste feed rate, and the rate of rotation.

### Revolutions Per Minute (RPM)

This parameter provides an indication of the turbulence that occurs in the primary chamber of a rotary kiln. As the turbulence increases, the quantity of heat transferred to the waste would also be expected to increase. However, as the RPM value increases, the residence time decreases resulting in a reduction of the quantity of heat transferred to the waste. This parameter needs to be carefully evaluated because it provides a balance between turbulence and residence time.

### iii. Fluidized Bed

As discussed previously, in the section on "Underlying Principles of Operation", the primary chamber accounts for almost all of the conversion of organic wastes to carbon dioxide, water vapor, and acid gas if halogens are present. The secondary chamber will generally provide additional residence time for thermal oxidation of the waste constituents. Relative to the primary chamber, the parameters that the Agency will examine in assessing the effectiveness of the design are temperature, residence time, and bed pressure differential. The first two were discussed under rotary kiln and will not be discussed here. The latter, bed pressure differential, is important in that it provides an indication of the amount of turbulence and, therefore, indirectly the amount of heat supplied to the waste. In general, as the pressure drop increases, both the turbulence and heat supplied increase. The pressure drop through the bed should be continuously monitored and recorded to ensure that the designed value is achieved.

### iv. Fixed Hearth

The design considerations for this incineration unit are similar to a rotary kiln with the exception that rate of rotation (i.e., RPMs) is not an applicable design parameter. For the primary chamber of this unit, the parameters that the Agency will examine in assessing how well the unit is designed are the same as discussed under rotary kiln; for the secondary chamber (i.e.,

afterburner), the design and operating parameters of concern are the same as previously discussed under "Liquid Injection".

(6) Incineration Performance Data

Performance data collected by EPA for rotary kiln incineration are presented in Tables 3-1 to 3-11. These tables present the analytical data for K101 and K102 collected during the Agency's sampling visit. The untreated K101 and K102 wastes, the treated K101 and K102 wastes (kiln ash) and the scrubber wastewater generated were analyzed for BDAT list volatile and semivolatile organic compounds and other parameters that affect incinerator performance.

Included in these tables are the design values and actual operating ranges for the key operating parameters of the rotary kiln incinerator system and the high performance scrubber system for each sample set collected.

TABLE 3-1 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF K101 BY INCINERATION - Sample Set #1<sup>a</sup>

Sample Location (EPA Sample Number)	Untreated K101 Waste to incinerator (S27-101)  (mg/kg)	Scrubber Wastewater  (S29-101)  (mg/l)
<b>BDAT LIST</b>		
Volatile Organics		
222 Acetone	<50	<0.010
43 Toluene	<25	<0.005
Semivolatile Organics		
70 Bis(2-ethylhexyl)Phthalate	<36,000	0.020
<b>NON-BDAT LIST</b>		
* 2-Nitroaniline	191,000	<0.050
Total Solids	748,000	10,400
Total Suspended Solids	NA	1,620
Total Dissolved Solids	NA	8,460
Total Organic Carbon	407,400	67.3**

OPERATING PARAMETERS	DESIGN VALUE	OPERATING RANGE
Incinerator System: -----		
Kiln temperature (deg. F), T1	1600-2000	1850 - 1960
Kiln exhaust temperature (deg. F), T2	1600-2000	1855 - 1961
Kiln pressure (in. H <sub>2</sub> O), KV	< -0.10	(-0.06) - (-0.12)
Kiln rotational speed (rpm), RS	0.25	0.25
Natural gas feed rate to kiln (MM Btu/hr), FGK	< 4	0.96 - 1.64
Natural gas pressure to kiln (psig), PGK	25	24.5 - 25
Afterburner temperature (deg. F), T3	2000	1984 - 2010
Natural gas feed rate to afterburner (MM Btu/hr), FGA	<4	0.880
Natural gas pressure to afterburner (psig), PGA	25	25
Quench tower temperature (deg. F), T4	Not controlled	445 - 595
Feed rate of K102 to kiln (lbs/hr), FW	500	204
Recirculation pump discharge pressure (psig), P1	80	80
Hydrosonic Scrubber System: -----		
Pressure drop across venturi flow meter (in. H <sub>2</sub> O), PV	>0	1.94 - 1.98
Pressure drop across Stage 1 (in. H <sub>2</sub> O), P1	20-25	27
Pressure drop across Stage 2 (in. H <sub>2</sub> O), P2	20-25	21.5
Total pressure drop across scrubber unit (in. H <sub>2</sub> O), PT	>30	38.5 - 39.5
Scrubber inlet temperature (deg. F), T5	Not controlled	200
Stage 1 nozzle temperature (deg. F), T6	Not controlled	180 - 182
Stage 2 nozzle temperature (deg. F), T7	Not controlled	175 - 180
Cyclone outlet temperature (deg. F), T8	Not controlled	175 - 180
Recirculated water flow to Stage 1 (gpm), W1	9.5-10.5	12
Recirculated water flow to Stage 2 (gpm), W2	5.5-6.5	6.0
Steam pressure (psig), PS	160-170	Not in operation
Steam temperature (deg. F), TS	370-380	Not in operation

a - Obtained from the Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K101. Tables 3-1, 3-2 and 5-3.

\* - Not on BDAT List

\*\* - This an average of two results for total organic carbon analysis on same sample.

NA - Not analyzed.

TABLE 3-2 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF K101 BY INCINERATION - Sample Set #2 <sup>a</sup>

Sample Location (EPA Sample Number)	Untreated K101 Waste to incinerator (S27-102) (mg/kg)	Scrubber Wastewater (S29-102) (mg/l)
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BDAT LIST

## Volatile Organics

222 Acetone	<50	<0.010
43 Toluene	<25	<0.005

## Semivolatile Organics

70 Bis(2-ethylhexyl)Phthalate	<38,000	0.013
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NON-BDAT LIST

* 2-Nitroaniline	<188,000	<0.050
Total Solids	793,000	32,000
Total Suspended Solids	NA	914
Total Dissolved Solids	NA	23,600
Total Organic Carbon	401,100	89.6**

OPERATING PARAMETERS	DESIGN VALUE	OPERATING RANGE
Incinerator System: -----		
Kiln temperature (deg. F), T1	1600-2000	1710 - 1940
Kiln exhaust temperature (deg. F), T2	1600-2000	1735 - 1914
Kiln pressure (in. H <sub>2</sub> O), KV	< -0.10	(-0.06) - (-0.20)
Kiln rotational speed (rpm), RS	0.25	0.25
Natural gas feed rate to kiln (MM Btu/hr), FGK	< 4	0.400 - 0.640
Natural gas pressure to kiln (psig), PGK	25	25
Afterburner temperature (deg. F), T3	2000	1991 - 2019
Natural gas feed rate to afterburner (MM Btu/hr), FGA	<4	0.640 - 0.920
Natural gas pressure to afterburner (psig), PGA	25	25
Quench tower temperature (deg. F), T4	Not controlled	474 - 543
Feed rate of K102 to kiln (lbs/hr), FW	500	196
Recirculation pump discharge pressure (psig), P1	80	75 - 80
Hydrosonic Scrubber System: -----		
Pressure drop across venturi flow meter (in. H <sub>2</sub> O), PV	>0	1.98 - 2.10
Pressure drop across Stage 1 (in. H <sub>2</sub> O), P1	20-25	27 - 28
Pressure drop across Stage 2 (in. H <sub>2</sub> O), P2	20-25	20 - 21
Total pressure drop across scrubber unit (in. H <sub>2</sub> O), PT	>30	38.5
Scrubber inlet temperature (deg. F), T5	Not controlled	205 - 210
Stage 1 nozzle temperature (deg. F), T6	Not controlled	184 - 188
Stage 2 nozzle temperature (deg. F), T7	Not controlled	174 - 175
Cyclone outlet temperature (deg. F), T8	Not controlled	175
Recirculated water flow to Stage 1 (gpm), W1	9.5-10.5	11.25 - 12
Recirculated water flow to Stage 2 (gpm), W2	5.5-6.5	6.0
Steam pressure (psig), PS	160-170	Not in operation
Steam temperature (deg. F), TS	370-380	Not in operation

a - Obtained from the Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K101. Tables 3-1, 3-2 and 5-4.

\* - Not on BDAT List

\*\* - This an average of two results for total organic carbon analysis on same sample.

NA - Not analyzed.

TABLE 3-3 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF K101 BY INCINERATION - Sample Set #3 <sup>a</sup>

Sample Location (EPA Sample Number)	Untreated K101 Waste to incinerator (S27-103)  (mg/kg)	Scrubber Wastewater  (S29-103)  (mg/l)
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BDAT LIST

## Volatile Organics

222 Acetone	<50	<0.010
43 Toluene	42	<0.005

## Semivolatile Organics

70 Bis(2-ethylhexyl)Phthalate	<34,000	0.011
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NON-BDAT LIST

* 2-Nitroaniline	<172,000	<0.050
Total Solids	804,000	18,500
Total Suspended Solids	NA	289
Total Dissolved Solids	NA	17,700
Total Organic Carbon	281,200	30.4**

OPERATING PARAMETERS	DESIGN VALUE	OPERATING RANGE
Incinerator System: -----		
Kiln temperature (deg. F), T1	1600-2000	1625 - 1940
Kiln exhaust temperature (deg. F), T2	1600-2000	1576 - 1880
Kiln pressure (in. H <sub>2</sub> O), KV	< -0.10	(-0.06) - (-0.10)
Kiln rotational speed (rpm), RS	0.25	0.25
Natural gas feed rate to kiln (MM Btu/hr), FGK	< 4	0.400
Natural gas pressure to kiln (psig), PGK	25	24.5
Afterburner temperature (deg. F), T3	2000	1940 - 1991
Natural gas feed rate to afterburner (MM Btu/hr), FGA	<4	0.92 - 0.96
Natural gas pressure to afterburner (psig), PGA	25	25
Quench tower temperature (deg. F), T4	Not controlled	458 - 513
Feed rate of K102 to kiln (lbs/hr), FW	500	192
Recirculation pump discharge pressure (psig), P1	80	75 - 80
Hydrosonic Scrubber System: -----		
Pressure drop across venturi flow meter (in. H <sub>2</sub> O), PV	>0	2.10 - 2.16
Pressure drop across Stage 1 (in. H <sub>2</sub> O), P1	20-25	27
Pressure drop across Stage 2 (in. H <sub>2</sub> O), P2	20-25	20
Total pressure drop across scrubber unit (in. H <sub>2</sub> O), PT	>30	38.5
Scrubber inlet temperature (deg. F), T5	Not controlled	205
Stage 1 nozzle temperature (deg. F), T6	Not controlled	180 - 188
Stage 2 nozzle temperature (deg. F), T7	Not controlled	175
Cyclone outlet temperature (deg. F), T8	Not controlled	170 - 175
Recirculated water flow to Stage 1 (gpm), W1	9.5-10.5	12
Recirculated water flow to Stage 2 (gpm), W2	5.5-6.5	6.0
Steam pressure (psig), PS	160-170	Not in operation
Steam temperature (deg. F), TS	370-380	Not in operation

a - Obtained from the Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K101. Tables 3-1, 3-2 and 5-5.

\* - Not on BDAT List

\*\* - This an average of two results for total organic carbon analysis on same sample.

NA - Not analyzed.

TABLE 3-4 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF K101 BY INCINERATION - Sample Set #4 <sup>a</sup>

Sample Location (EPA Sample Number)	Untreated K101 Waste to incinerator (SZ7-104) (mg/kg)	Scrubber Wastewater (SZ9-104) (mg/l)
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BDAT LIST

## Volatile Organics

222 Acetone	81	<0.010
43 Toluene	<25	<0.005

## Semivolatile Organics

70 Bis(2-ethylhexyl)Phthalate	<38,000	0.012
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NON-BDAT LIST

* 2-Nitroaniline	<190,000	<0.050
Total Solids	604,000	22,600
Total Suspended Solids	NA	373
Total Dissolved Solids	NA	21,100
Total Organic Carbon	254,900	38.0**

OPERATING PARAMETERS	DESIGN VALUE	OPERATING RANGE
Incinerator System: -----		
Kiln temperature (deg. F), T1	1600-2000	1700
Kiln exhaust temperature (deg. F), T2	1600-2000	1383 - 1631
Kiln pressure (in. H <sub>2</sub> O), KV	< -0.10	0 - (-0.10)
Kiln rotational speed (rpm), RS	0.25	0.25
Natural gas feed rate to kiln (MM Btu/hr), FGK	< 4	0.40 - 2.00
Natural gas pressure to kiln (psig), PGK	25	24.5
Afterburner temperature (deg. F), T3	2000	1868 - 1891
Natural gas feed rate to afterburner (MM Btu/hr), FGA	<4	0.96
Natural gas pressure to afterburner (psig), PGA	25	24 - 24.5
Quench tower temperature (deg. F), T4	Not controlled	467 - 486
Feed rate of K102 to kiln (lbs/hr), FW	500	129
Recirculation pump discharge pressure (psig), P1	80	80
Hydrosonic Scrubber System: -----		
Pressure drop across venturi flow meter (in. H <sub>2</sub> O), PV	>0	2.0 - 2.25
Pressure drop across Stage 1 (in. H <sub>2</sub> O), P1	20-25	27
Pressure drop across Stage 2 (in. H <sub>2</sub> O), P2	20-25	20
Total pressure drop across scrubber unit (in. H <sub>2</sub> O), PT	>30	38.5 - 40.6
Scrubber inlet temperature (deg. F), T5	Not controlled	205
Stage 1 nozzle temperature (deg. F), T6	Not controlled	178
Stage 2 nozzle temperature (deg. F), T7	Not controlled	175
Cyclone outlet temperature (deg. F), T8	Not controlled	170 - 172
Recirculated water flow to Stage 1 (gpm), W1	9.5-10.5	12
Recirculated water flow to Stage 2 (gpm), W2	5.5-6.5	6.0
Steam pressure (psig), PS	160-170	Not in operation
Steam temperature (deg. F), TS	370-380	Not in operation

a - Obtained from the Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K101. Tables 3-1, 3-2 and 5-6.

\* - Not on BDAT List

\*\* - This an average of two results for total organic carbon analysis on same sample.

NA - Not analyzed.



TABLE 3-5 ANALYTICAL RESULTS FOR TREATMENT OF K101 BY INCINERATION - Sample Sets 2A, 2B, and 1 <sup>a</sup>

Sample Location (EPA Sample Number)	Treated Waste (Kiln Ash) (2A) TOTAL (mg/kg)	Treated Waste (Kiln Ash) (2B) TOTAL (mg/kg)	Treated Waste (Kiln Ash) (1) TOTAL (mg/kg)
<u>BDAT List</u>			
Volatile Organics			
222 Acetone	0.010	<0.010	<0.010
43 Toluene	<0.005	<0.005	<0.005
Semivolatile Organics			
70 Bis(2-ethylhexyl)Phthlate	<0.420	<0.420	<0.420
<u>NON -BDAT List</u>			
* 2-Nitroaniline	<2	<2	<2
Total Solids (%)	94.5	94.8	96.2
Total Suspended Solids	NA	NA	NA
Total Dissolved Solids	NA	NA	NA
Total Organic Carbon	267**	795**	2,130**

a - Obtained from the Onsite Engineering Report, John Zink Company, Tulsa, Oklahoma for K101, Table 5-7.

\* - Constituent is not on the BDAT list.

\*\* - This is an average of four results for Total Organic Carbon analysis on same sample.

NA - Not analyzed.

TABLE 3-6 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF K102 BY INCINERATION - Sample Set #1<sup>a</sup>

Sample Location (EPA Sample Number)	Untreated K102 Waste to incinerator (S24-101)  (mg/kg)	Treated Waste (Kiln Ash) (S25-101) Total (mg/kg)	Scrubber Wastewater (S26-101)  (mg/l)
<u>BDAT LIST</u>			
Volatile Organics			
43 Toluene	9.4	<1.5	<0.005
215-217 Total Xylenes	<1.5	<1.5	<0.005
Semivolatile Organics			
70 Bis(2-ethylhexyl)Phthalate	<182	<1.0	0.016
142 Phenol	<182	<1.0	0.017
<u>NON-BDAT LIST</u>			
* 2-Nitrophenol	370	<1.0	<0.010
Total Solids	337,000	732,500**	6200
Total Suspended Solids	NA	NA	1,980
Total Dissolved Solids	NA	NA	1,930
Total Organic Carbon	173,200	22,400***	17.1***
<hr/>			
OPERATING PARAMETERS		DESIGN VALUE	OPERATING RANGE
<hr/>			
Incinerator System: -----			
Kiln temperature (deg. F), T1		1600-2000	2000
Kiln exhaust temperature (deg. F), T2		1600-2000	1889-1892
Kiln pressure (in. H <sub>2</sub> O), KV		< -0.10	(-0.01)-(-0.02)
Kiln rotational speed (rpm), RS		0.25	0.25
Natural gas feed rate to kiln (MM Btu/hr), FGK		< 4	1.92
Natural gas pressure to kiln (psig), PGK		25	25
Afterburner temperature (deg. F), T3		2000	1928-1934
Natural gas feed rate to afterburner (MM Btu/hr), FGA		<4	0.88-1.04
Natural gas pressure to afterburner (psig), PGA		25	20-27.5
Quench tower temperature (deg. F), T4		Not controlled	486-496
Feed rate of K102 to kiln (lbs/hr), FW		500	565
Recirculation pump discharge pressure (psig), P1		80	80
 Hydrosonic Scrubber System: -----			
Pressure drop across venturi flow meter (in. H <sub>2</sub> O), PV		>0	1.62-1.68
Pressure drop across Stage 1 (in. H <sub>2</sub> O), P1		20-25	21.5-27.0
Pressure drop across Stage 2 (in. H <sub>2</sub> O), P2		20-25	20.0-21.0
Total pressure drop across scrubber unit (in. H <sub>2</sub> O), PT		>30	30.5-31.0
Scrubber inlet temperature (deg. F), T5		Not controlled	200
Stage 1 nozzle temperature (deg. F), T6		Not controlled	170-172
Stage 2 nozzle temperature (deg. F), T7		Not controlled	180-185
Cyclone outlet temperature (deg. F), T8		Not controlled	180
Recirculated water flow to Stage 1 (gpm), W1		9.5-10.5	10.1-10.5
Recirculated water flow to Stage 2 (gpm), W2		5.5-6.5	6.0-6.5
Steam pressure (psig), PS		160-170	180-185
Steam temperature (deg. F), TS		370-380	375

a - Obtained from the Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K102. Tables 3-2, 3-3 and 5-3.

\* - Not on BDAT List

\*\* - This an average of two results for total solids analysis on same sample.

\*\*\* - This an average of four results for total organic carbon analysis on same sample.

NA - Not analyzed.

TABLE 3-7 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF K102 BY INCINERATION - Sample Set #2 <sup>a</sup>

Sample Location (EPA Sample Number)	Untreated K102 Waste to incinerator (S24-102)  (mg/kg)	Treated Waste (Kiln Ash) (S25-102) Total (mg/kg)	Scrubber Wastewater (S26-102)  (mg/l)
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BDAT LIST

## Volatile Organics

43 Toluene	5.4	<1.5	<0.005
215-217 Total Xylenes	<1.5	<1.5	<0.005

## Semivolatile Organics

70 Bis(2-ethylhexyl)Phthalate	<19.4	<1.0	<0.010
142 Phenol	<19.4	<1.0	0.019T

NON-BDAT LIST

* 2-Nitrophenol	220	<1.0	<0.010
Total Solids	356,000	706,000**	5,130
Total Suspended Solids	NA	NA	2,910
Total Dissolved Solids	NA	NA	2,610
Total Organic Carbon	166,000	24,200***	22.9***

OPERATING PARAMETERS	DESIGN VALUE	OPERATING RANGE
Incinerator System:		
Kiln temperature (deg. F), T1	1600-2000	1860-1950
Kiln exhaust temperature (deg. F), T2	1600-2000	1864-1924
Kiln pressure (in. H <sub>2</sub> O), KV	< -0.10	-0.05
Kiln rotational speed (rpm), RS	0.25	0.25
Natural gas feed rate to kiln (MM Btu/hr), FGK	< 4	1.04-1.20
Natural gas pressure to kiln (psig), PGK	25	25
Afterburner temperature (deg. F), T3	2000	1949
Natural gas feed rate to afterburner (MM Btu/hr), FGA	<4	0.92-0.96
Natural gas pressure to afterburner (psig), PGA	25	20
Quench tower temperature (deg. F), T4	Not controlled	486-509
Feed rate of K102 to kiln (lbs/hr), FW	500	565
Recirculation pump discharge pressure (psig), P1	80	80
Hydrosonic Scrubber System:		
Pressure drop across venturi flow meter (in. H <sub>2</sub> O), PV	>0	1.54-1.64
Pressure drop across Stage 1 (in. H <sub>2</sub> O), P1	20-25	20.5-21.0
Pressure drop across Stage 2 (in. H <sub>2</sub> O), P2	20-25	19.5-21.0
Total pressure drop across scrubber unit (in. H <sub>2</sub> O), PT	>30	30.0-30.5
Scrubber inlet temperature (deg. F), T5	Not controlled	200
Stage 1 nozzle temperature (deg. F), T6	Not controlled	176-178
Stage 2 nozzle temperature (deg. F), T7	Not controlled	180-185
Cyclone outlet temperature (deg. F), T8	Not controlled	180-182
Recirculated water flow to Stage 1 (gpm), W1	9.5-10.5	9.75
Recirculated water flow to Stage 2 (gpm), W2	5.5-6.5	6.5
Steam pressure (psig), PS	160-170	165-167
Steam temperature (deg. F), TS	370-380	375

a - Obtained from Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K102. Tables 3-2, 3-3 and 5-4.

\* - Constituent has not yet been assigned a BDAT number.

\*\* - This an average of two results for total solids analysis on same sample.

\*\*\* - This an average of four results for total organic carbon analysis on same sample.

NA - Not analyzed.

T - This value is under investigation by laboratory to confirm compound's presence.

TABLE 3-8 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF K102 BY INCINERATION - Sample Set #3 <sup>a</sup>

Sample Location (EPA Sample Number)	Untreated K102 Waste to incinerator (SZ4-103)  (mg/kg)	Treated Waste (Kiln Ash) (SZ5-103) Total (mg/kg)	Scrubber Wastewater (SZ6-103)  (mg/l)
<b>BDAT LIST</b>			
Volatile Organics			
43 Toluene	5.7	<1.5	<0.005
215-217 Total Xylenes	<1.5	<1.5	<0.005
Semivolatile Organics			
70 Bis(2-ethylhexyl)Phthalate	<19.4	<1.0	0.022
142 Phenol	<19.4	<1.0	<0.010
<b>NON-BDAT LIST</b>			
* 2-Nitrophenol	230	<1.0	<0.010
Total Solids	355,000	601,500**	5,130
Total Suspended Solids	NA	NA	4,440
Total Dissolved Solids	NA	NA	2,550
Total Organic Carbon	167,800	36,700***	23.9***
<hr/>			
OPERATING PARAMETERS	DESIGN VALUE	OPERATING RANGE	
<hr/>			
Incinerator System: -----			
Kiln temperature (deg. F), T1	1600-2000	1800-1850	
Kiln exhaust temperature (deg. F), T2	1600-2000	1850-1879	
Kiln pressure (in. H <sub>2</sub> O), KV	< -0.10	0.0-0.15*	
Kiln rotational speed (rpm), RS	0.25	0.25	
Natural gas feed rate to kiln (MM Btu/hr), FGK	< 4	1.00-1.04	
Natural gas pressure to kiln (psig), PGK	25	25	
Afterburner temperature (deg. F), T3	2000	1925-1928	
Natural gas feed rate to afterburner (MM Btu/hr), FGA	<4	0.80	
Natural gas pressure to afterburner (psig), PGA	25	25	
Quench tower temperature (deg. F), T4	Not controlled	480	
Feed rate of K102 to kiln (lbs/hr), FW	500	515	
Recirculation pump discharge pressure (psig), P1	80	80	
 Hydrosonic Scrubber System: -----			
Pressure drop across venturi flow meter (in. H <sub>2</sub> O), PV	>0	1.46-1.56	
Pressure drop across Stage 1 (in. H <sub>2</sub> O), P1	20-25	21.5-26.0	
Pressure drop across Stage 2 (in. H <sub>2</sub> O), P2	20-25	20.5-21.0	
Total pressure drop across scrubber unit (in. H <sub>2</sub> O), PT	>30	30.5-31.0	
Scrubber inlet temperature (deg. F), T5	Not controlled	200	
Stage 1 nozzle temperature (deg. F), T6	Not controlled	178	
Stage 2 nozzle temperature (deg. F), T7	Not controlled	185	
Cyclone outlet temperature (deg. F), T8	Not controlled	182	
Recirculated water flow to Stage 1 (gpm), W1	9.5-10.5	10.5	
Recirculated water flow to Stage 2 (gpm), W2	5.5-6.5	6.5-6.6	
Steam pressure (psig), PS	160-170	170-180	
Steam temperature (deg. F), TS	370-380	375	

a - Obtained from the Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K102. Tables 3-2, 3-3 and 5-5.

\* - Not on BOAT List

\*\* - This is an average of two results for total solids analysis on same sample.

\*\*\* - This is an average of four results for total organic carbon analysis on same sample.

NA - Not analyzed.

TABLE 3-9 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF K102 BY INCINERATION - Sample Set #4<sup>a</sup>

Sample Location (EPA Sample Number)	Untreated K102 Waste to incinerator (S24-104)  (mg/kg)	Treated Waste (Kiln Ash) (S25-104) Total (mg/kg)	Scrubber Wastewater (S26-104)  (mg/l)
<b>BDAT LIST</b>			
Volatile Organics			
43 Toluene	6.1	<1.5	<0.005
215-217 Total Xylenes	<1.5	<1.5	<0.005
Semivolatile Organics			
70 Bis(2-ethylhexyl)Phthalate	<194	<1.0	0.031
142 Phenol	<194	<1.0	0.023
<b>NON-BDAT LIST</b>			
* 2-Nitrophenol	480	<1.0	<0.010
Total Solids	333,000	400,500**	8,260
Total Suspended Solids	NA	NA	6,290
Total Dissolved Solids	NA	NA	2,620
Total Organic Carbon	163,100	422,000***	25.9***
<b>OPERATING PARAMETERS</b>			
<b>DESIGN VALUE</b>		<b>OPERATING RANGE</b>	
Incinerator System:			
-----			
Kiln temperature (deg. F), T1	1600-2000	1750-1775	
Kiln exhaust temperature (deg. F), T2	1600-2000	1817-1827	
Kiln pressure (in. H <sub>2</sub> O), KV	< -0.10	(-0.05)-(-0.10)	
Kiln rotational speed (rpm), RS	0.25	0.25	
Natural gas feed rate to kiln (MM Btu/hr), FGK	< .4	1.04-1.12	
Natural gas pressure to kiln (psig), PGK	25	25	
Afterburner temperature (deg. F), T3	2000	1931-1953	
Natural gas feed rate to afterburner (MM Btu/hr), FGA	<4	0.76	
Natural gas pressure to afterburner (psig), PGA	25	25	
Quench tower temperature (deg. F), T4	Not controlled	482-490	
Feed rate of K102 to kiln (lbs/hr), FW	500	414	
Recirculation pump discharge pressure (psig), P1	80	75-80	
Hydrosonic Scrubber System:			
-----			
Pressure drop across venturi flow meter (in. H <sub>2</sub> O), PV	>0	1.52-1.54	
Pressure drop across Stage 1 (in. H <sub>2</sub> O), P1	20-25	21.0-21.5	
Pressure drop across Stage 2 (in. H <sub>2</sub> O), P2	20-25	21.0	
Total pressure drop across scrubber unit (in. H <sub>2</sub> O), PT	>30	31.5-35.5	
Scrubber inlet temperature (deg. F), T5	Not controlled	200	
Stage 1 nozzle temperature (deg. F), T6	Not controlled	176	
Stage 2 nozzle temperature (deg. F), T7	Not controlled	182-185	
Cyclone outlet temperature (deg. F), T8	Not controlled	180-183	
Recirculated water flow to Stage 1 (gpm), W1	9.5-10.5	10.5	
Recirculated water flow to Stage 2 (gpm), W2	5.5-6.5	6.6	
Steam pressure (psig), PS	160-170	162-195	
Steam temperature (deg. F), TS	370-380	372-380	

a - Obtained from the Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K102. Tables 3-2, 3-3 and 5-6.

\* - Not on BDAT List

\*\* - This an average of two results for total solids analysis on same sample.

\*\*\* - This an average of four results for total organic carbon analysis on same sample.

NA - Not analyzed.

TABLE 3-10 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF K102 BY INCINERATION - Sample Set #5 <sup>a</sup>

Sample Location (EPA Sample Number)	Untreated K102 Waste to incinerator (SZ4-105)  (mg/kg)	Treated Waste (Kiln Ash) (SZ5-105) Total (mg/kg)	Scrubber Wastewater (SZ6-105)  (mg/l)
<b>BDAT LIST</b>			
Volatile Organics			
43 Toluene	23		<0.005
215-217 Total Xylenes	4.5		<0.005
Semivolatile Organics			
70 Bis(2-ethylhexyl)Phthalate	<194	NO	0.021
142 Phenol	<194		0.015
SAMPLES			
<b>NON-BDAT LIST</b>			
* 2-Nitrophenol	740	TAKEN	<0.010
Total Solids	393,000		8,920
Total Suspended Solids	NA		6,210
Total Dissolved Solids	NA		2,530
Total Organic Carbon	214,700		30.3**
<hr/>			
OPERATING PARAMETERS		DESIGN VALUE	OPERATING RANGE
<hr/>			
Incinerator System: -----			
Kiln temperature (deg. F), T1		1600-2000	1780
Kiln exhaust temperature (deg. F), T2		1600-2000	1837-1848
Kiln pressure (in. H <sub>2</sub> O), KV		< -0.10	-0.08
Kiln rotational speed (rpm), RS		0.25	0.25-0.29
Natural gas feed rate to kiln (MM Btu/hr), FGK		< 4	1.12
Natural gas pressure to kiln (psig), PGK		25	25
Afterburner temperature (deg. F), T3		2000	1928-1930
Natural gas feed rate to afterburner (MM Btu/hr), FGA		<4	0.76
Natural gas pressure to afterburner (psig), PGA		25	25
Quench tower temperature (deg. F), T4		Not controlled	491-518
Feed rate of K102 to kiln (lbs/hr), FW		500	414
Recirculation pump discharge pressure (psig), P1		80	75-77
 Hydrosonic Scrubber System: -----			
Pressure drop across venturi flow meter (in. H <sub>2</sub> O), PV		>0	1.50
Pressure drop across Stage 1 (in. H <sub>2</sub> O), P1		20-25	21.5
Pressure drop across Stage 2 (in. H <sub>2</sub> O), P2		20-25	20.5
Total pressure drop across scrubber unit (in. H <sub>2</sub> O), PT		>30	30.5-31.0
Scrubber inlet temperature (deg. F), T5		Not controlled	200
Stage 1 nozzle temperature (deg. F), T6		Not controlled	176-178
Stage 2 nozzle temperature (deg. F), T7		Not controlled	185
Cyclone outlet temperature (deg. F), T8		Not controlled	182
Recirculated water flow to Stage 1 (gpm), W1		9.5-10.5	10.1
Recirculated water flow to Stage 2 (gpm), W2		5.5-6.5	6.6
Steam pressure (psig), PS		160-170	165
Steam temperature (deg. F), TS		370-380	375

a - Obtained from the Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K102. Tables 3-2, 3-3 and 5-7.

\* - Not on BDAT List

\*\* - This an average of two results for total organic carbon analysis on same sample.

NA - Not analyzed.

TABLE 3-11 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF K102 BY INCINERATION - Sample Set #6 <sup>a</sup>

Sample Location (EPA Sample Number)	Untreated K102 Waste to incinerator (S24-106) (mg/kg)	Treated Waste (Kiln Ash) (S25-106) Total (mg/kg)	Scrubber Wastewater (S26-106) (mg/l)
<b>BDAT LIST</b>			
Volatile Organics			
43 Toluene	26		<0.005
215-217 Total Xylenes	5.3		<0.005
Semivolatile Organics			
70 Bis(2-ethylhexyl)Phthalate	<184		0.012
142 Phenol	<184		0.017
SAMPLES			
<b>NON-BDAT LIST</b>			
* 2-Nitrophenol	870	TAKEN	<0.010
Total Solids	395,000		9,160
Total Suspended Solids	NA		6,410
Total Dissolved Solids	NA		2,370
Total Organic Carbon	216,500		35.9**
<b>OPERATING PARAMETERS</b>			
<b>DESIGN VALUE</b>			
<b>OPERATING RANGE</b>			
Incinerator System:			
-----			
Kiln temperature (deg. F), T1	1600-2000	1740	
Kiln exhaust temperature (deg. F), T2	1600-2000	1810-1828	
Kiln pressure (in. H <sub>2</sub> O), KV	< -0.10	(-0.09)-(-0.12)	
Kiln rotational speed (rpm), RS	0.25	0.29	
Natural gas feed rate to kiln (MM Btu/hr), FGK	< 4	1.08-1.12	
Natural gas pressure to kiln (psig), PGK	25	25	
Afterburner temperature (deg. F), T3	2000	1971-1976	
Natural gas feed rate to afterburner (MM Btu/hr), FGA	<4	0.76	
Natural gas pressure to afterburner (psig), PGA	25	25	
Quench tower temperature (deg. F), T4	Not controlled	526-560	
Feed rate of K102 to kiln (lbs/hr), FW	500	389	
Recirculation pump discharge pressure (psig), P1	80	74-77	
Hydrosonic Scrubber System:			
-----			
Pressure drop across venturi flow meter (in. H <sub>2</sub> O), PV	>0	1.50-1.52	
Pressure drop across Stage 1 (in. H <sub>2</sub> O), P1	20-25	21.5-22.0	
Pressure drop across Stage 2 (in. H <sub>2</sub> O), P2	20-25	20.5-21.0	
Total pressure drop across scrubber unit (in. H <sub>2</sub> O), PT	>30	30.5-31.5	
Scrubber inlet temperature (deg. F), T5	Not controlled	200	
Stage 1 nozzle temperature (deg. F), T6	Not controlled	176-182	
Stage 2 nozzle temperature (deg. F), T7	Not controlled	185	
Cyclone outlet temperature (deg. F), T8	Not controlled	180-182	
Recirculated water flow to Stage 1 (gpm), W1	9.5-10.5	9.9-10.5	
Recirculated water flow to Stage 2 (gpm), W2	5.5-6.5	6.3-6.6	
Steam pressure (psig), PS	160-170	160-190	
Steam temperature (deg. F), TS	370-380	370-380	

a - Obtained from the Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K102.  
Tables 3-2, 3-3 and 5-8.

\* - Not on BDAT List

\*\* - This an average of two results for total organic carbon analysis on same sample.

NA - Not analyzed.

### 3.3.2 Stabilization of Metals

Stabilization refers to a broad class of treatment processes that chemically reduce the mobility of hazardous constituents in a waste. Solidification and fixation are other terms that are sometimes used synonymously for stabilization or to describe specific variations within the broader class of stabilization. Related technologies are encapsulation and thermoplastic binding; however, EPA considers these technologies to be distinct from stabilization in that the operational principles are significantly different.

#### (1) Applicability and Use of Stabilization

Stabilization is used when a waste contains metals that will leach from the waste when it is contacted by water. In general, this technology is applicable to wastes containing BDAT list metals, having a high filterable solids content, low TOC content, and low oil and grease content. This technology is commonly used to treat residuals generated from treatment of electroplating wastewaters. For some wastes, an alternative to stabilization is metal recovery.



## (2) Underlying Principles of Operation

The basic principle underlying this technology is that stabilizing agents and other chemicals are added to a waste in order to minimize the amount of metal that leaches. The reduced leachability is accomplished by the formation of a lattice structure and/or chemical bonds that bind the metals to the solid matrix and, thereby, limit the amount of metal constituents that can be leached when water or a mild acid solution comes into contact with the waste material.

There are two principal stabilization processes used; these are cement based and lime based. A brief discussion of each is provided below. In both cement-based or lime/pozzolan-based techniques, the stabilizing process can be modified through the use of additives, such as silicates, that control curing rates or enhance the properties of the solid material.

### i. Portland Cement-Based Process

Portland cement is a mixture of powdered oxides of calcium, silica, aluminum, and iron, produced by kiln burning of materials rich in calcium and silica at high temperatures (i.e., 1400°C to 1500°C). When the anhydrous cement powder is mixed with water, hydration occurs and the cement begins to set. The chemistry involved is complex because many different reactions occur depending on the composition of the cement mixture.

As the cement begins to set, a colloidal gel of indefinite composition and structure is formed. Over a period of time, the gel swells and forms a matrix composed of interlacing, thin, densely-packed silicate fibrils. Constituents present in the waste slurry (e.g., hydroxides and carbonates of various heavy metals, are incorporated into the interstices of the cement matrix. The high pH of the cement mixture tends to keep metals in the form of insoluble hydroxide and carbonate salts.) It has been hypothesized that metal ions may also be incorporated into the crystal structure of the cement matrix, but this hypothesis has not been verified.

ii. Lime/Pozzolan-Based Process

Pozzolan, which contains finely divided, noncrystalline silica (e.g., fly ash or components of cement kiln dust), is a material that is not cementitious in itself, but becomes so upon the addition of lime. Metals in the waste are converted to silicates or hydroxides which inhibit leaching. Additives, again, can be used to reduce permeability and thereby further decrease leaching potential.

(3) Description of Stabilization Processes

In most stabilization processes, the waste, stabilizing agent, and other additives, if used, are mixed and then pumped to a curing vessel or area and allowed to cure. The actual

operation (equipment requirements and process sequencing) will depend on several factors such as the nature of the waste, the quantity of the waste, the location of the waste in relation to the disposal site, the particular stabilization formulation to be used, and the curing rate. After curing, the solid formed is recovered from the processing equipment and shipped for final disposal.

In instances where waste contained in a lagoon is to be treated, the material should be first transferred to mixing vessels where stabilizing agents are added. The mixed material is then fed to a curing pad or vessel. After curing, the solid formed is removed for disposal. Equipment commonly used also includes facilities to store waste and chemical additives. Pumps can be used to transfer liquid or light sludge wastes to the mixing pits and pumpable uncured wastes to the curing site. Stabilized wastes are then removed to a final disposal site.

Commercial concrete mixing and handling equipment generally can be used with wastes. Weighing conveyors, metering cement hoppers, and mixers similar to concrete batching plants have been adapted in some operations. Where extremely dangerous materials are being treated, remote-control and in-drum mixing equipment, such as that used with nuclear waste, can be employed.

#### (4) Waste Characteristics Affecting Performance

In determining whether stabilization is likely to achieve the same level of performance on an untested waste as on a previously tested waste, the Agency will focus on the characteristics that inhibit the formation of either the chemical bonds or the lattice structure. The four characteristics EPA has identified as affecting treatment performance are the presence of (1) fine particulates, (2) oil and grease, (3) organic compounds, and (4) certain inorganic compounds.

##### i. Fine Particulates

For both cement-based and lime/pozzolan-based processes, the literature states that very fine solid materials (i.e., those that pass through a No. 200 mesh sieve, 74 um particle size) can weaken the bonding between waste particles and cement by coating the particles. This coating can inhibit chemical bond formation and decreases the resistance of the material to leaching.

##### ii. Oil and Grease

The presence of oil and grease in both cement-based and lime/pozzolan-based systems results in the coating of waste particles and the weakening of the bonding between the particle and the stabilizing agent. This coating can inhibit chemical bond formation and thereby, decrease the resistance of the material to leaching.

### iii. Organic Compounds

The presence of organic compounds in the waste interferes with the chemical reactions and bond formation which inhibit curing of the stabilized material. This results in a stabilized waste having decreased resistance to leaching. The total organic carbon content for K101 and K102 nonwastewaters is 267 to 2,130 mg/kg for K101 and 24,200 to 422,000 mg/kg for K102.

### iv. Sulfate and Chlorides

The presence of certain inorganic compounds will interfere with the chemical reactions, weakening bond strength and prolonging setting and curing time. Sulfate and chloride compounds may reduce the dimensional stability of the cured matrix, thereby increasing leachability potential..

Accordingly, EPA will examine these constituents when making decisions regarding transfer of treatment standards based on stabilization. The amounts of sulfate in K101 and K102 nonwastewaters are 148 to 193 mg/kg and 12 to 55.9 mg/kg, respectively. Chlorides are present at 8.7 to 11.1 mg/kg in K101 and 71.5 to 103 mg/kg in K102.

## (5) Design and Operating Parameters

In designing a stabilization system, the principal parameters that are important to optimize so that the amount of

leachable metal constituents is minimized are (1) selection of stabilizing agents and other additives, (2) ratio of waste to stabilizing agents and other additives, (3) degree of mixing, and (4) curing conditions.

(1) Selection of stabilizing agents and other additives.

The stabilizing agent and additives used will determine the chemistry and structure of the stabilized material and, therefore, will affect the leachability of the solid material. Stabilizing agents and additives must be carefully selected based on the chemical and physical characteristics of the waste to be stabilized. For example, the amount of sulfates in a waste must be considered when a choice is being made between a lime/pozzolan and a Portland cement-based system.

In order to select the type of stabilizing agents and additives, the waste should be tested in the laboratory with a variety of materials to determine the best combination.

(2) Amount of stabilizing agents and additives. The amount of stabilizing agents and additives is a critical parameter in that sufficient stabilizing materials are necessary in the mixture to bind the waste constituents of concern properly, thereby making them less susceptible to leaching. The appropriate weight ratios of waste to stabilizing agent and other additives are established empirically by setting up a series of

laboratory tests that allow separate leachate testing of different mix ratios. The ratio of water to stabilizing agent (including water in waste) will also impact the strength and leaching characteristics of the stabilized material. Too much water will cause low strength; too little will make mixing difficult and, more importantly, may not allow the chemical reactions that bind the hazardous constituents to be fully completed.

(3) Mixing. The conditions of mixing include the type and duration of mixing. Mixing is necessary to ensure homogeneous distribution of the waste and the stabilizing agents. Both undermixing and overmixing are undesirable. The first condition results in a nonhomogeneous mixture; therefore, areas will exist within the waste where waste particles are neither chemically bonded to the stabilizing agent nor physically held within the lattice structure. Overmixing, on the other hand, may inhibit gel formation and ion adsorption in some stabilization systems. As with the relative amounts of waste, stabilizing agent, and additives within the system, optimal mixing conditions generally are determined through laboratory tests. During treatment it is important to monitor the degree (i.e., type and duration) of mixing to ensure that it reflects design conditions.

(4) Curing conditions. The curing conditions include the duration of curing and the ambient curing conditions (temperature and humidity). The duration of curing is a critical parameter to ensure that the waste particles have had sufficient time in which to form stable chemical bonds and/or lattice structures. The time necessary for complete stabilization depends upon the waste type and the stabilization used. The performance of the stabilized waste (i.e., the levels of constituents in the leachate) will be highly dependent upon whether complete stabilization has occurred. Higher temperatures and lower humidity increase the rate of curing by increasing the rate of evaporation of water from the solidification mixtures. However, if temperatures are too high, the evaporation rate can be excessive and result in too little water being available for completion of the stabilization reaction. The duration of the curing process should also be determined during the design stage and typically will be between 7 and 28 days.

(6) Stabilization Performance Data

Performance data for the stabilization of K101 and K102 kiln ash and precipitated metals from the scrubber waters was not collected by EPA. Therefore, performance data will be transferred from the stabilization of waste code F006 (a non-specific waste from non-specific sources) which is similar based on waste characteristics affecting performance. Tables 3-12 and



3-13 present analytical data for K101 and K102 kiln ash. The kiln ash was analyzed for BDAT list metals and other parameters that affect the stabilization process. The analytical results for the treatment of F006 by stabilization are shown in Tables 3-14 and 3-15. Table 3-16 presents the composition data for the cement kiln dust used in the stabilization process.

### 3.3.3 Chemical Precipitation

#### (1) Applicability and Use of Chemical Precipitation

Chemical precipitation is used when dissolved metals are to be removed from solution. This technology can be applied to a wide range of wastewaters containing dissolved BDAT list metals and other metals as well. This treatment process has been practiced widely by industrial facilities since the 1940s.

#### (2) Underlying Principles of Operation

The underlying principle of chemical precipitation is that metals in wastewater are removed by the addition of a treatment chemical that converts the dissolved metal to a metal precipitate. This precipitate is less soluble than the original metal compound, and therefore settles out of solution, leaving a lower concentration of the metal present in the solution. The principal chemicals used to convert soluble metal compounds to

TABLE 3-12 ANALYTICAL RESULTS FOR UNTREATED K101 KILN ASH - Sample Sets 2A, 2B, and 1<sup>a</sup>

Sample Location (EPA Sample Number)	Untreated Waste (Kiln Ash) (2A)		Untreated Waste (Kiln Ash) (2B)		Untreated Waste (Kiln Ash) (1)	
	TOTAL (mg/kg)	TCLP (mg/l)	TOTAL (mg/kg)	TCLP (mg/l)	TOTAL (mg/kg)	TCLP (mg/l)
<u>BDAT LISTED</u>						
Metals						
154 Antimony	104	0.377	88	0.462	87	0.204
155 Arsenic	360	0.656	244	0.730	355	0.376
156 Barium	294	0.485	288	0.537	289	0.594
157 Beryllium	0.56	<0.001	0.54	<0.001	0.52	0.0011
158 Cadmium	<0.50	0.0088	<0.50	0.0094	<0.50	0.0051
159 Chromium	232	0.143	206	0.127	261	0.232
160 Copper	554	1.30	540	1.060	417	1.030
161 Lead	6.3	0.009	7.2	<0.0005	8.2	<0.005
162 Mercury	<0.1	<0.0002	<0.1	<0.0002	<0.1	<0.0002
163 Nickel	297	0.450	265	0.379	262	0.366
164 Selenium	<0.5	<0.005	<0.5	<0.010	<0.5	<0.025
165 Silver	0.86	<0.007	<0.70	<0.007	<0.70	<0.007
166 Thallium	<1.0	<0.010	<1.0	<0.010	<1.0	<0.010
167 Vanadium	31	0.014	30	0.020	27	0.025
168 Zinc	173	0.323	166	0.391	132	0.293
Inorganic						
171 Sulfide	13.6	NA	16.9	NA	20.5	NA
<u>NON-BDAT LISTED</u>						
Chlorides	8.7	NA	11.1	NA	11.0	NA
Sulfate	148	NA	172	NA	193	NA
Total Organic Carbon	267**	NA	795**	NA	2,130**	NA

a - Obtained from the Onsite Engineering Report, John Zink Company, Tulsa, Oklahoma for K101, Table 5-7.

\*\* - This is an average of four results for Total Organic Carbon analysis on same sample.

NA - Not analyzed.

TABLE 3-13 ANALYTICAL RESULTS FOR UNTREATED K102 KILN ASH - Sample Sets 1, 2, 3, and 4 <sup>a</sup>

		Untreated Waste (Kiln Ash)							
		Sample Set 1		Sample Set 2		Sample Set 3		Sample Set 4	
		Total (mg/kg)	TCLP (mg/l)	Total (mg/kg)	TCLP (mg/l)	Total (mg/kg)	TCLP (mg/l)	Total (mg/kg)	TCLP (mg/l)
<u>BDAT LISTED</u>									
Metals									
3-50	154 Antimony	369	8.02	349	8.140	1990	16.3	203	9.73
	155 Arsenic	633	8.69	844	14.3	1060	17.1	1,080	38.3
	156 Barium	39	0.206	32	0.218	30	0.273	15	0.241
	157 Beryllium	<0.1	<0.001	<0.1	<0.001	<0.1	<0.001	<0.1	<0.001
	158 Cadmium	1.3	0.020	1.4	0.029	4.2	0.059	<0.5	0.084
	159 Chromium	32	0.019	42	0.0052	12	<0.007	15	0.286
	160 Copper	42	0.343	46	0.103	36	0.048	8.7	0.0082
	161 Lead	11	<0.005	10.5	<0.005	<0.5	0.0056	1.7	<0.005
	162 Mercury	0.12	<0.0002	<0.1	<0.0002	<0.1	<0.0002	<0.1	0.00021
	163 Nickel	56	0.370	76	0.541	35	0.383	9.1	0.428
3-50	164 Selenium	8.0	<0.050	6.7	0.054	7.6	0.036	13	<0.005
	165 Silver	<0.7	<0.007	<0.7	<0.007	<0.7	<0.007	<0.7	<0.007
	166 Thallium	<5.0	<0.500	<1.0	<0.200	<1.0	<0.200	<1.0	<0.100
	167 Vanadium	4.3	<0.004	3.4	<0.004	2.5	<0.004	0.73	<0.004
	168 Zinc	24	0.285	21	0.526	12	0.577	2.3	0.214
Inorganics									
	171 Sulfide	7.0	NA	6.4	NA	7.9	NA	8.7	NA
<u>NON-BDAT LISTED</u>									
	Chlorides	83.9	NA	89.3	NA	103	NA	71.5	NA
	Sulfate	12.0	NA	21.4	NA	18.8	NA	55.9	NA
	Total Organic Carbon	22,400***	NA	24,200***	NA	36,700***	NA	422,000***	NA

<sup>a</sup> - Obtained from the Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K102. Tables 5-3 through 5-6.

\*\*\* - This an average of four results for total organic carbon analysis on same sample.

NA - Not analyzed.

TABLE 3-14 ANALYTICAL RESULTS FOR UNTREATED F006 WASTE

Total Concentration in Raw Waste Sample - F006 (ppm)									
	#1	#2	#3	#4	#5	#6	#7	#8	#9
BDAT CONSTITUENT									
Barium	--	--	85.5	--	14.3	--	--	15.3	19.2
Cadmium	--	31.3	67.3	1.31	720	7.28	5.39	5.81	--
Chromium	--	755	716	--	12,200	3,100	42,900	--	--
Copper	--	7,030	--	1,510	160	1,220	10,600	17,600	27,400
Lead	--	409	257	88.5	52	113	156	1.69	24,500
Nickel	435	989	259	374	701	19,400	13,000	23,700	5,730
Silver	--	6.62	38.9	9.05	5.28	4.08	12.5	8.11	--
Zinc	1,560	4,020	631	90,200	35,900	27,800	120	15,700	322

1 - Wastewater treatment sludge cake - no free liquid.

2 - Site closure excavation mud at auto part manufacturer. The waste sample is a mixture of F006 and F007.

3 - Waste treatment sludge from aircraft overhaul facility. The waste sample is a mixture of F006, D006, D007, and D008.

4 - Zinc electroplating sludge.

5 - Filter cake from electroplating wastewater treatment.

6 - Sludge from treatment of Cr, Cu, Ni, and Zn plating.

7 - Wastewater treatment sludge from plating on plastics.

8 - Wastewater treatment sludge.

9 - To be provided

Source: CWM Technical Note 87-117.

TABLE 3-14 ANALYTICAL RESULTS FOR UNTREATED F006 WASTE (Continued)

TCLP Concentration in Raw Waste Sample - F006 (ppm)									
	#1	#2	#3	#4	#5	#6	#7	#8	#9
BDAT CONSTITUENT									
Barium	--	--	1.41	--	0.38	--	--	0.53	0.28
Cadmium	--	2.21	1.13	0.02	23.6	0.3	0.06	0.18	--
Chromium	--	0.76	0.43	--	25.3	38.7	360	--	--
Copper	--	368	--	4.62	1.14	31.7	8.69	483	16.9
Lead	--	10.7	2.26	0.45	0.45	3.37	1.0	4.22	50.2
Nickel	0.71	22.7	1.1	0.52	9.78	730	152	644	16.1
Silver	--	0.14	0.20	0.16	0.08	0.12	0.05	0.31	--
Zinc	0.16	219	5.41	2,030	867	1,200	0.62	650	1.29

1 - Wastewater treatment sludge cake - no free liquid.

2 - Site closure excavation mud at auto part manufacturer. The waste sample is a mixture of F006 and F007.

3 - Waste treatment sludge from aircraft overhaul facility. The waste sample is a mixture of F006, D006, D007, and D008.

4 - Zinc electroplating sludge.

5 - Filter cake from electroplating wastewater treatment.

6 - Sludge from treatment of Cr, Cu, Ni, and Zn plating.

7 - Wastewater treatment sludge from plating on plastics.

8 - Wastewater treatment sludge.

9 - To be provided

Source: CWM Technical Note 87-117.

TABLE 3-15 ANALYTICAL RESULTS FOR TREATED F006 WASTE

TCLP Concentration in Treated Sample - F006 (ppm)									
	#1	#2	#3	#4	#5	#6	#7	#8	#9
Mix Ratio	0.2	0.5	0.2	1.0	0.5	0.5	0.2	0.5	0.5
BDAT CONSTITUENT									
Barium	--	--	0.33	--	0.23	--	--	0.27	0.08
Cadmium	--	0.01	0.06	0.01	0.01	0.01	0.01	0.01	--
Chromium	--	0.39	0.08	--	0.30	0.38	1.21	--	--
Copper	--	0.25	--	0.15	0.27	0.29	0.42	0.32	0.46
Lead	--	0.36	0.30	0.21	0.34	0.36	0.38	0.37	0.27
Nickel	0.04	0.03	0.23	0.02	0.03	0.04	0.10	0.04	0.02
Silver	--	0.05	0.20	0.03	0.04	0.06	0.05	0.05	--
Zinc	0.03	0.01	0.05	0.01	0.04	0.03	0.02	0.02	<0.01

- 1 - Wastewater treatment sludge cake - no free liquid.
- 2 - Site closure excavation mud at auto part manufacturer. The waste sample is a mixture of F006 and F007.
- 3 - Waste treatment sludge from aircraft overhaul facility. The waste sample is a mixture of F006, D006, D007, and D008.
- 4 - Zinc electroplating sludge.
- 5 - Filter cake from electroplating wastewater treatment.
- 6 - Sludge from treatment of Cr, Cu, Ni, and Zn plating.
- 7 - Wastewater treatment sludge from plating on plastics.
- 8 - Wastewater treatment sludge.
- 9 - To be provided

Source: CWM Technical Note 87-117.

TABLE 3-16 CEMENT KILN DUST COMPOSITION DATA

Constituent	Concentration in mg/l		
	Composition	TCLP/EP*	Other Characteristics
Aluminum	31,000	NA	
Arsenic	38	<0.01	
Barium	92.7	2.74	
Cadmium	3.14	<0.01	
Chromium (total)	31.9	0.05	
Copper	44.8	0.16	
Iron (total)	15,200	NA	
Lead	156	0.29	
Magnesium	3,790	NA	
Mercury	<0.033	<0.001	
Nickel	12.6	0.02	
Selenium	8.67	0.03	
Silver	4.13	0.02	
Zinc	65.6	0.04	
Sodium	2300	NA	
Potassium	33,100	NA	
Calcium	41,900	NA	
Total Sulfide ppm			<8
Asn content %			99.8
Total residue @ 105 c%			100
Alkalinity as CA0%			56.16
pH 10% solution			12.55

NA - Not reported.

\* - In the process of checking with CWM for the type of analysis performed.

Source: Special Waste Analysis Report dated June 15, 1987  
provided by Chemical Waste Management, Technical Center.

the less soluble forms include: lime ( $\text{Ca}(\text{OH})_2$ ), caustic ( $\text{NaOH}$ ), sodium sulfide ( $\text{Na}_2\text{S}$ ), and, to a lesser extent, soda ash ( $\text{Na}_2\text{CO}_3$ ), phosphate, and ferrous sulfide ( $\text{FeS}$ ).

The solubility of a particular compound will depend on the extent to which the electrostatic forces holding the ions of the compound together can be overcome. The solubility will change significantly with temperature; most metal compounds are more soluble as the temperature increases. Additionally, the solubility will be affected by the other constituents present in a waste. As a general rule, nitrates, chlorides, and sulfates are more soluble than hydroxides, sulfides, carbonates, and phosphates.

An important concept related to treatment of the soluble metal compounds is pH. This term provides a measure of the extent to which a solution contains either an excess of hydrogen or hydroxide ions. The pH scale ranges from 0 to 14; with 0 being the most acidic, 14 representing the highest alkalinity or hydroxide ion ( $\text{OH}^-$ ) content, and 7.0 being neutral.

When hydroxide is used, as is often the case, to precipitate the soluble metal compounds, the pH is frequently monitored to ensure that sufficient treatment chemicals are added. It is important to point out that pH is not a good measure of treatment chemical addition for compounds other than hydroxides; when



sulfide is used, for example, facilities might use an oxidation-reduction potential meter (ORP) correlation to ensure that sufficient treatment chemical is used.

Following conversion of the relatively soluble metal compounds to metal precipitates, the effectiveness of chemical precipitation is a function of the physical removal, which usually relies on a settling process. A particle of a specific size, shape, and composition will settle at a specific velocity, as described by Stokes' Law. For a batch system, Stokes' law is a good predictor of settling time because the pertinent particle parameters remain essentially constant. Nevertheless, in practice, settling time for a batch system is normally determined by empirical testing. For a continuous system, the theory of settling is complicated by factors such as turbulence, short-circuiting, and velocity gradients, increasing the importance of the empirical tests.

### (3) Description of the Technology

The equipment and instrumentation required for chemical precipitation varies depending on whether the system is batch or continuous. Both operations are discussed below; a schematic of the continuous system is shown in Figure 3-5.

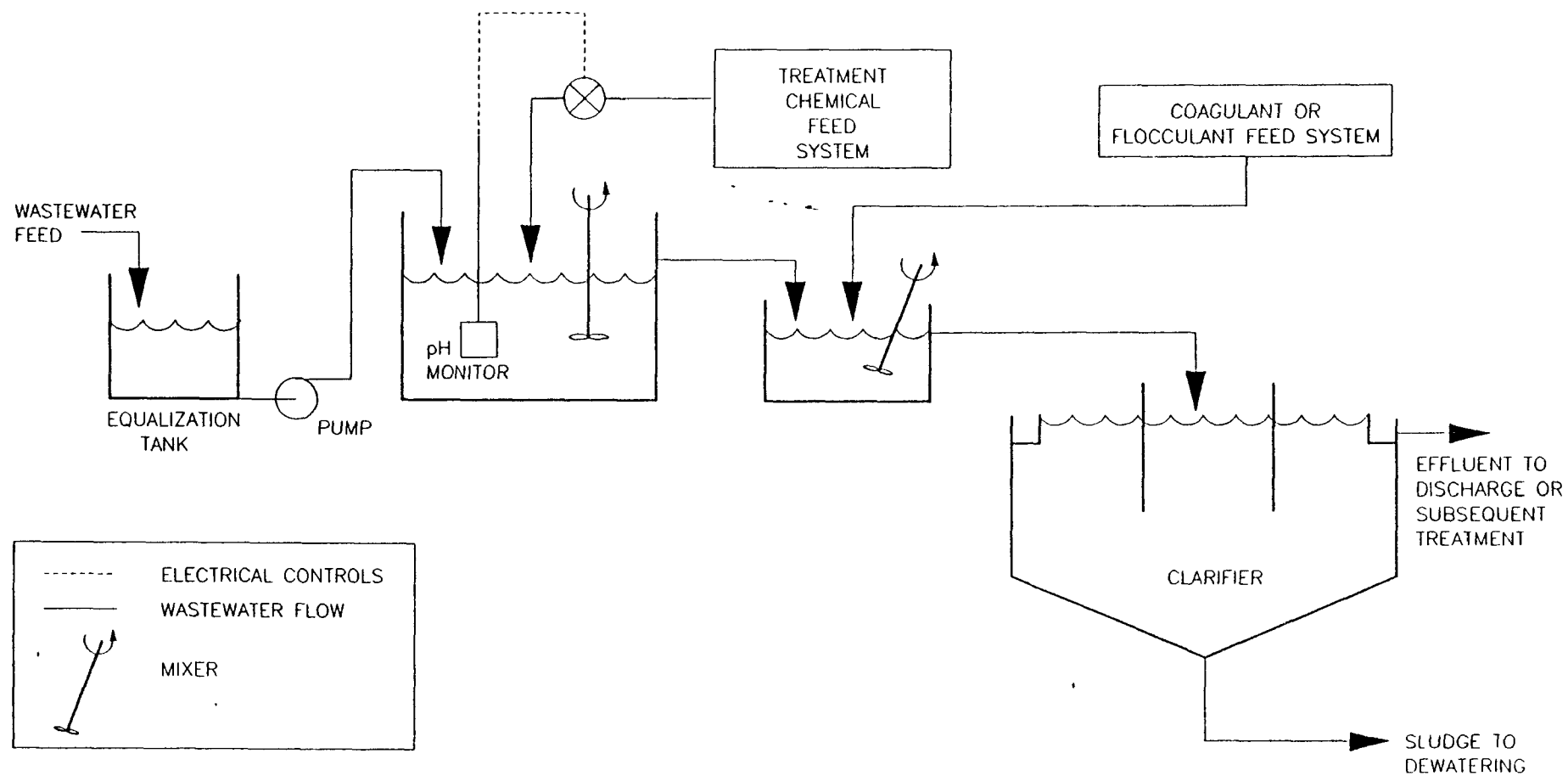


FIGURE 3-5 CONTINUOUS CHEMICAL PRECIPITATION

For a batch system, chemical precipitation requires only a feed system for the treatment chemicals and a second tank where the waste can be treated and allowed to settle. When lime is used, it is usually added to the reaction tank in a slurry form. In a batch system, the supernate is usually analyzed before discharge, thus minimizing the need for instrumentation.

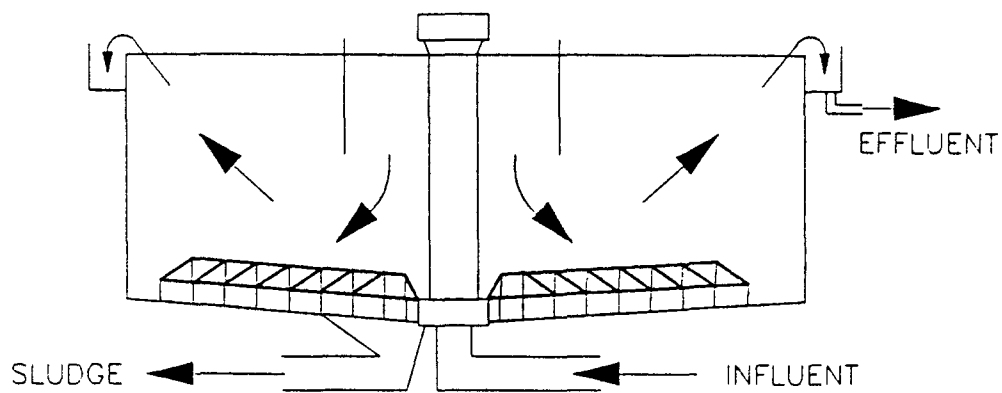
In a continuous system, additional tanks are necessary, as well as instrumentation to ensure that the system is operating properly. In this system, the first tank that the wastewater enters is referred to as an equalization tank. This is where the waste can be mixed in order to provide more uniformity, minimizing wide swings in the type and concentration of constituents being sent to the reaction tank. It is important to reduce the variability of the waste sent to the reaction tank because control systems inherently are limited with regard to the maximum fluctuations that can be managed.

Following equalization, the waste is pumped to a reaction tank where treatment chemicals are added; this is done automatically by using instrumentation that senses the pH of the system and then pneumatically adjusts the position of the treatment chemical feed valve such that the design pH value is achieved. Both the complexity and the effectiveness of the automatic control system will vary depending on the variation in

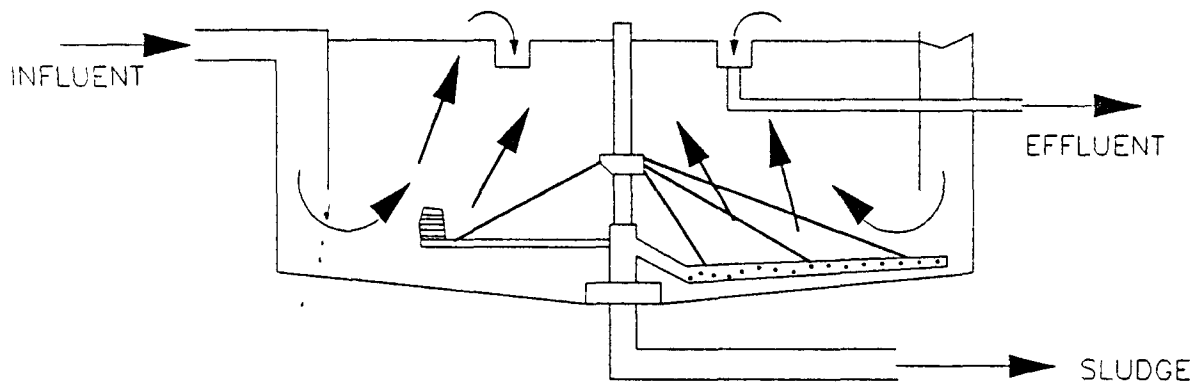
the waste and the pH range that is needed to properly treat the waste.

An important aspect of the reaction tank design is that it be well-mixed so that the waste and the treatment chemicals are both dispersed throughout the tank, in order to ensure commingling of the reactant and the treatment chemicals. In addition, effective dispersion of the treatment chemicals throughout the tank is necessary to properly monitor and, thereby, control the amount of treatment chemicals added.

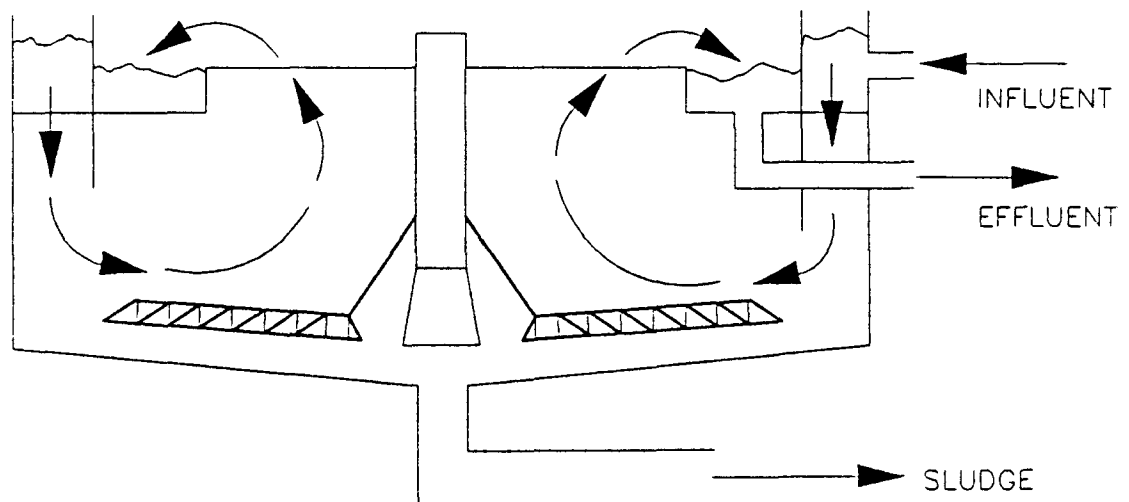
After the waste is reacted with the treatment chemical, it flows to a quiescent tank where the precipitate is allowed to settle and subsequently be removed. Settling can be chemically assisted through the use of flocculating compounds. Flocculants increase the particle size and density of the precipitated solids, both of which increase the rate of settling. The particular flocculating agent that will best improve settling characteristics will vary depending on the particular waste; selection of the flocculating agent is generally accomplished by performing laboratory bench tests. Settling can be conducted in a large tank by relying solely on gravity or be mechanically assisted through the use of a circular clarifier or an inclined separator. Schematics of the latter two separators are shown in Figures 3-6 and 3-7.



CENTER FEED CLARIFIER WITH SCRAPER SLUDGE REMOVAL SYSTEM



RIM FEED - CENTER TAKEOFF CLARIFIER WITH  
HYDRAULIC SUCTION SLUDGE REMOVAL SYSTEM



RIM FEED - RIM TAKEOFF CLARIFIER

FIGURE 3-6 CIRCULAR CLARIFIERS

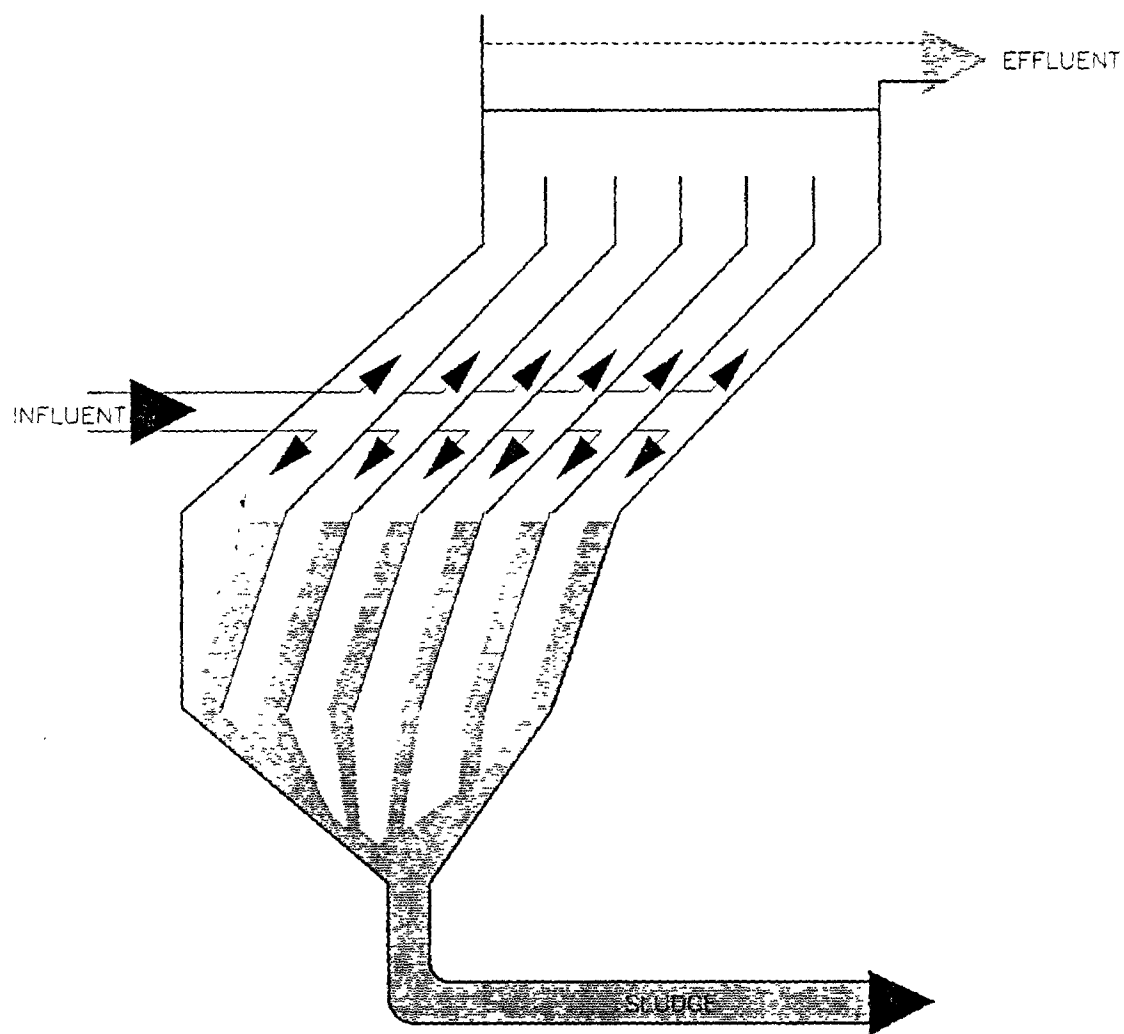


FIGURE 3-7  
INCLINED PLATE SETTLER

Filtration can be used for further removal of precipitated residuals both in cases where the settling system is underdesigned and in cases where the particles are difficult to settle. Polishing filtration is discussed in a separate technology section.

#### (4) Waste Characteristics Affecting Performance

In determining whether chemical precipitation is likely to achieve the same level of performance on an untested waste as a previously tested waste, we will examine the following waste characteristics: (i) the concentration and type of the metal(s) in the waste, (ii) the concentration of suspended solids (TSS), (iii) the concentration of dissolved solids (TDS), (iv) whether the metal exists in the wastewater as a complex, and (v) the oil and grease content. These parameters either affect the chemical reaction of the metal compound, the solubility of the metal precipitate, or the ability of the precipitated compound to settle.

(i) Concentration and type of metals. For most metals, there is a specific pH at which the metal hydroxide is least soluble. As a result, when a waste contains a mixture of many metals, it is not possible to operate a treatment system at a single pH which is optimal for the removal of all metals. The extent to which this affects treatment depends on the particular

metals to be removed, and their concentrations. An alternative can be to operate multiple precipitations, with intermediate settling, when the optimum pH occurs at markedly different levels for the metals present. The individual metals and their concentrations can be measured using EPA Method 6010.

(ii) Concentration and type of total suspended solids (TSS). Certain suspended solid compounds are difficult to settle because of either their particle size or shape. Accordingly, EPA will evaluate this characteristic in assessing transfer of treatment performance. Total suspended solids can be measured by EPA Wastewater Test Method 160.2. The amount of total suspended solids present in the K101 and K102 wastewaters are 289 to 1,620 mg/l and 1,980 to 6,140 mg/l, respectively.

(iii) Concentration of total dissolved solids (TDS). Available information shows that total dissolved solids can inhibit settling. The literature states that poor flocculation is a consequence of high TDS and shows that higher concentrations of total suspended solids are found in treated residuals. Poor flocculation can adversely affect the degree to which precipitated particles are removed. Total dissolved solids can be measured by EPA Wastewater Test Method 160.1. The amount of total dissolved solids present in the K101 and K102 wastewaters are 8,460 to 23,600 mg/l and 1,930 to 2,620 mg/l, respectively.



(iv) Complexed metals. Metal complexes consist of a metal ion surrounded by a group of other inorganic or organic ions or molecules (often called ligands). In the complexed form, the metals have a greater solubility and, therefore, may not be as effectively removed from solution by chemical precipitation. EPA does not have an analytical method to determine the amount of complexed metals in the waste. The Agency believes that the best measure of complexed metals is to analyze for some common complexing compounds (or complexing agents) generally found in wastewater for which analytical methods are available. These complexing agents include ammonia, cyanide, and EDTA. The analytical method for cyanide is EPA Method 9010. The method for EDTA is ASTM Method D3113. Ammonia can be analyzed using EPA Wastewater Test Method 350.

(v) Oil and grease content. The oil and grease content of a particular waste directly inhibits the settling of the precipitate. Suspended oil droplets float in water and tend to suspend particles such as chemical precipitates that would otherwise settle out of the solution. Even with the use of coagulants or flocculants, the separation of the precipitate is less effective. Oil and grease content can be measured by EPA Method 9071.

## (5) Design and Operating Parameters

The parameters that EPA will evaluate when determining whether a chemical precipitation system is well designed are: (1) design value for treated metal concentrations, as well as other characteristics of the waste used for design purposes (e.g., total suspended solids), (2) pH, (3) residence time, (4) choice of treatment chemical, and (5) choice of coagulant/flocculant. Below is an explanation of why EPA believes these parameters are important to a design analysis; in addition, EPA explains why other design criteria are not included in EPA's analysis.

(1) Treated and untreated design concentrations. EPA pays close attention to the treated concentration the system is designed to achieve when determining whether to sample a particular facility. Since the system will seldom out-perform its design, EPA must evaluate whether the design is consistent with best demonstrated practice.

The untreated concentrations that the system is designed to treat are important in evaluating any treatment system. Operation of a chemical precipitation treatment system with untreated waste concentrations in excess of design values can easily result in poor performance.

(2) pH. The pH is important, because it can indicate that sufficient treatment chemical (e.g., lime) is added to convert the metal constituents in the untreated waste to forms that will precipitate. The pH also affects the solubility of metal hydroxides and sulfides, and therefore directly impacts the effectiveness of removal. In practice, the design pH is determined by empirical bench testing, often referred to as "jar" testing. The temperature at which the "jar" testing is conducted is important in that it also affects the solubility of the metal precipitates. Operation of a treatment system at temperatures above the design temperature can result in poor performance. In assessing the operation of a chemical precipitation system, EPA prefers continuous data on the pH and periodic temperature conditions throughout the treatment period.

(3) Residence time. The residence time is important because it impacts the completeness of the chemical reaction to form the metal precipitate and, to a greater extent, amount of precipitate that settles out of solution. In practice, it is determined by "jar" testing. For continuous systems, EPA will monitor the feed rate to ensure that the system is operated at design conditions. For batch systems, EPA will want information on the design parameter used to determine sufficient settling time (e.g., total suspended solids).

(4) Choice of treatment chemical. A choice must be made as to what type of precipitating agent (i.e., treatment chemical) will be used. The factor that most affects this choice is the type of metal constituents to be treated. Other design parameters, such as pH, residence time, and choice of coagulant/flocculant agents, are based on the selection of the treatment chemical.

(5) Choice of coagulant/flocculant. This is important because these compounds improve the settling rate of the precipitated metals and allows for smaller systems (i.e., lower retention time) to achieve the same degree of settling as a much larger system. In practice, the choice of the best agent and the required amount is determined by "jar" testing.

(6) Mixing. The degree of mixing is a complex assessment which includes, among other things, the energy supplied, the time the material is mixed, and the related turbulence effects of the specific size and shape of the tank. EPA will, however, consider whether mixing is provided and whether the type of mixing device is one that could be expected to achieve uniform mixing. For example, EPA may not use data from a chemical precipitation treatment system where an air hose was placed in a large tank to achieve mixing.

#### (6) Chemical Precipitation Performance Data

Performance data for chemical precipitation of K101 and K102 scrubber waters was not collected by EPA. Therefore, performance data will be transferred from the data obtained for the chemical precipitation of D004 waste. Tables 3-17 and 3-18 present analytical data for K101 and K102 scrubber water. The scrubber water was analyzed for BDAT list metals and other parameters that affect the precipitation process. The analytical results and operating data for the treatment of D004 by precipitation are shown in Tables 3-19 to 3-23.

TABLE 3-17 ANALYTICAL RESULTS FOR UNTREATED K101 SCRUBBER WATER <sup>a</sup>

		Untreated Scrubber Water			
		Sample Set 1	Sample Set 2	Sample Set 3	Sample Set 4
		Total	Total	Total	Total
		(mg/l)	(mg/l)	(mg/l)	(mg/l)
<u>BDAT LISTED</u>					
Metals					
154	Antimony	404	296	136	137
155	Arsenic	426	504	307	91.7
156	Barium	0.425	0.462	0.447	0.480
157	Beryllium	<0.001	<0.001	<0.001	<0.001
158	Cadmium	<0.050	<0.500	<0.005	<0.500
159	Chromium	1.120	1.71	1.16	0.962
160	Copper	3.170	7.13	3.97	3.56
161	Lead	3.620	3.87	2.00	1.97
162	Mercury	0.040	0.109	0.069	0.0057
163	Nickel	0.649	1.210	0.907	0.983
164	Selenium	0.389	0.121	<0.050	<0.500
165	Silver	0.048	<0.007	<0.070	<0.070
166	Thallium	0.377	0.167	0.056	0.037
167	Vanadium	0.027	0.058	0.036	0.038
168	Zinc	10.9	19.3	13.8	14.8
<u>NON-BDAT LISTED</u>					
Total Solids		10,400	32,000	18,500	22,600
Total Suspended Solids		1,620	914	289	373
Total Dissolved Solids		8,460	23,600	17,700	21,100

a - Obtained from the Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K101. Tables 5-3 through 5-6.

TABLE 3-18 ANALYTICAL RESULTS FOR UNTREATED K102 SCRUBBER WATER <sup>a</sup>

		Untreated Scrubber Water					
		Sample Set 1	Sample Set 2	Sample Set 3	Sample Set 4	Sample Set 5	Sample Set 6
		Total	Total	Total	Total	Total	Total
		(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
<b><u>BDAT LISTED</u></b>							
Metals							
154	Antimony	591	513	627	489	291	712
155	Arsenic	341	495	641	663	668	713
156	Barium	0.207	0.198	0.375	0.560	0.648	0.323
157	Beryllium	<0.010	<0.001	<0.001	0.0017	0.0018	0.002
158	Cadmium	0.671	0.834	2.8	0.887	0.436	0.283
159	Chromium	0.606	0.372	0.379	0.410	0.606	0.565
160	Copper	1.120	1.170	1.220	1.310	1.690	1.490
161	Lead	0.245	0.081	0.132	0.567	0.323	<0.005
162	Mercury	0.018	0.022	0.036	0.053	0.036	0.041
163	Nickel	<0.220	<0.220	<0.220	0.092	0.228	0.018
164	Selenium	0.131	0.170	0.413	0.223	0.170	0.119
165	Silver	0.007	0.0099	0.011	0.013	0.016	0.014
166	Thallium	0.246	0.370	0.562	0.449	0.417	0.417
167	Vanadium	0.032	0.040	0.034	0.023	0.025	0.028
168	Zinc	1.280	1.230	1.340	1.460	1.850	1.790
<b><u>NON-BDAT LISTED</u></b>							
Total Solids		6,200	5,130	5,380	8,260	8,920	9,160
Total Suspended Solids		1,980	2,910	4,440	6,290	6,210	6,410
Total Dissolved Solids		1,930	2,610	2,550	2,620	2,530	2,370

a - Obtained from the Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K102.  
Tables 5-3 through 5-8.

TABLE 3-19 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF D004 BY CHEMICAL PRECIPITATION <sup>a</sup>SAMPLE SET 1

	UNTREATED WASTE		TREATED WASTE
	Basin #5	Basin #6	
<hr/>			
<u>BDAT LIST</u>			
Metals (mg/l)			
154 Antimony	3.740	2.9	<0.640
155 Arsenic	826	1,260	0.415
156 Barium	<0.020	0.025	<0.200
157 Beryllium	0.021	<0.020	<0.020
158 Cadmium	2.990	3.980	<0.080
159 Chromium	<0.140	<0.140	<0.140
160 Copper	<1.2	<1.200	0.266
161 Lead	0.044	0.298	<0.005
162 Mercury	0.019	0.036	0.0014
163 Nickel	<0.220	<0.220	<0.220
164 Selenium	<0.025	<0.050	<0.050
165 Silver	<0.120	<0.120	<0.120
166 Thallium	<0.100	<0.010	<0.010
167 Vanadium	<0.120	<0.120	<0.120
168 Zinc	0.473	1.220	0.709

Continued



TABLE 3-19 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF D004 BY CHEMICAL PRECIPITATION <sup>a</sup>  
(Continued)

SAMPLE SET 1

OPERATING PARAMETERS	DESIGN VALUE	OPERATING RANGE	
Calcium Hydroxide Precipitator:		Basin #5	Basin #6
-----		-----	-----
Incoming Waste Arsenic Content (ppm)	500 - 5,000	826	1,260
Untreated Waste pH	2 - 8	10.94	4.04
Molar Ratio of Treatment Chemical to Arsenic	1.5:1 Min.	1.5	2.2
Mixing Time (min)	15 - 30	25	30
Amount of Flocculant Added (gal)	2 - 5	5	3
Waste Volume (gal)	8,000	8,850	8,030
Treated Waste pH	11.2 - 11.5	12.18	12.34
Reaction Temperature (°C)	Ambient	27.1	28.1
Manganese Sulfate Precipitator:			
-----			
Incoming Waste Arsenic Content (ppm)	100 - 1,000	143	
Untreated Waste pH	11.2 - 11.5	12.01	
Amount of Chemical Treatment Added (lbs)	495	495	
Molar Ratio of Treatment Chemical to Arsenic	1.2:1 - 12:1	9.5	
Mixing Time (min)	30	35	
Amount of Flocculant Added (gal)	3 - 5	5	
Waste Volume (gal)	16,200	16,200	
Treated Waste pH	8.0 - 8.5	7.39	
Reaction Temperature (°C)	Ambient	25.6	
Ferric Sulfate Precipitator:			
-----			
Incoming Waste Arsenic Content (ppm)	10 - 100	23.4	
Untreated Waste pH	8.0 - 8.5	7.42	
Amount of Chemical Treatment Added (lbs)	50 lbs/10 ppm* Arsenic	100	
Molar Ratio of Treatment Chemical to Arsenic	9:1	8.8	
Mixing Time (min)	30	30	
Amount of Flocculant Added (gal)	3 - 5	5	
Waste Volume (gal)	16,000	15,700	
Treated Waste pH	4.4 - 4.6	3.79	
Reaction Temperature (°C)	Ambient	32.9	

\*Plant experience is normally used in chemical addition with color of incoming waste being the indicator.  
a - Obtained from Onsite Engineering Report for Salsbury Laboratories for D004, Tables 3-1 through 3-3.

TABLE 3-20 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF D004 BY CHEMICAL PRECIPITATION <sup>a</sup>SAMPLE SET 2

	UNTREATED WASTE		TREATED WASTE
	Basin #5	Basin #6	
<hr/>			
<u>BDAT LIST</u>			
Metals (mg/l)			
154 Antimony	1.090	1.460	<0.640
155 Arsenic	427	960	2.000
156 Barium	0.325	<0.020	0.032
157 Beryllium	<0.020	<0.020	<0.020
158 Cadmium	1.090	3.080	<0.080
159 Chromium	<0.140	<0.140	<0.140
160 Copper	<0.120	<1.200	0.321
161 Lead	0.075	<0.005	0.029
162 Mercury	0.076	0.142	0.0043
163 Nickel	<0.220	<0.220	<0.220
164 Selenium	<0.025	<0.025	<0.050
165 Silver	<0.120	<0.120	<0.120
166 Thallium	<0.010	<0.010	0.011
167 Vanadium	<0.120	<0.120	<0.120
168 Zinc	1.000	0.749	1.150

Continued

TABLE 3-20 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF D004 BY CHEMICAL PRECIPITATION <sup>a</sup>  
(Continued)

SAMPLE SET 2

OPERATING PARAMETERS	DESIGN VALUE	OPERATING RANGE	
Calcium Hydroxide Precipitator:		Basin #5	Basin #6
-----		-----	-----
Incoming Waste Arsenic Content (ppm)	500 - 5,000	427	960
Untreated Waste pH	2 - 8	7.06	2.17
Molar Ratio of Treatment Chemical to Arsenic	1.5:1 Min.	4.8	1.5
Mixing Time (min)	15 - 30	25	20
Amount of Flocculant Added (gal)	2 - 5	3	2
Waste Volume (gal)	8,000	7,950	7,650
Treated Waste pH	11.2 - 11.5	12.82	11.96
Reaction Temperature (°C)	Ambient	27.0	35.2
Manganese Sulfate Precipitator:			
-----			
Incoming Waste Arsenic Content (ppm)	100 - 1,000	147	
Untreated Waste pH	11.2 - 11.5	11.80	
Amount of Chemical Treatment Added (lbs)	495	495	
Molar Ratio of Treatment Chemical to Arsenic	1.2:1 - 12:1	11.2	
Mixing Time (min)	30	30	
Amount of Flocculant Added (gal)	3 - 5	5	
Waste Volume (gal)	16,200	13,400	
Treated Waste pH	8.0 - 8.5	8.06	
Reaction Temperature (°C)	Ambient	27.6	
Ferric Sulfate Precipitator:			
-----			
Incoming Waste Arsenic Content (ppm)	10 - 100	35.9	
Untreated Waste pH	8.0 - 8.5	7.60	
Amount of Chemical Treatment Added (lbs)	50 lbs/10 ppm* Arsenic	100	
Molar Ratio of Treatment Chemical to Arsenic	9:1	6.3	
Mixing Time (min)	30	30	
Amount of Flocculant Added (gal)	3 - 5	5	
Waste Volume (gal)	16,000	14,300	
Treated Waste pH	4.4 - 4.6	4.17	
Reaction Temperature (°C)	Ambient	26.4	

\*Plant experience is normally used in chemical addition with color of incoming waste being the indicator.  
a - Obtained from Onsite Engineering Report for Salsbury Laboratories for D004, Tables 3-1 through 3-3.

TABLE 3-21 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF D004 BY CHEMICAL PRECIPITATION <sup>a</sup>SAMPLE SET 3

	UNTREATED WASTE		TREATED WASTE
	Basin #5	Basin #6	
<hr/>			
<u>BDAT LIST</u>			
Metals (mg/l)			
154 Antimony	0.914	4.110	<0.640
155 Arsenic	1,280	706	0.513
156 Barium	0.269	<0.020	<0.020
157 Beryllium	<0.020	<0.020	<0.020
158 Cadmium	3.250	2.590	<0.080
159 Chromium	<0.140	<0.140	<0.140
160 Copper	<0.120	<0.120	0.267
161 Lead	0.279	0.078	0.025
162 Mercury	0.112	0.190	0.0094
163 Nickel	<0.220	<0.220	<0.220
164 Selenium	<0.050	<0.005	<0.050
165 Silver	<0.120	<0.120	<0.120
166 Thallium	<1.000	<0.010	<0.010
167 Vanadium	<0.120	<0.120	<0.120
168 Zinc	0.617	1.170	0.743

Continued

TABLE 3-21 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF D004 BY CHEMICAL PRECIPITATION <sup>a</sup>  
(Continued)

SAMPLE SET 3

OPERATING PARAMETERS	DESIGN VALUE	OPERATING RANGE	
<hr/>			
Calcium Hydroxide Precipitator:		Basin #5	Basin #6
-----		-----	-----
Incoming Waste Arsenic Content (ppm)	500 - 5,000	1,280	706
Untreated Waste pH	2 - 8	2.01	7.61
Molar Ratio of Treatment Chemical to Arsenic	1.5:1 Min.	2.0	1.8
Mixing Time (min)	15 - 30	25	30
Amount of Flocculant Added (gal)	2 - 5	5	5
Waste Volume (gal)	8,000	8,700	8,100
Treated Waste pH	11.2 - 11.5	12.09	12.31
Reaction Temperature ( °C)	Ambient	30.8	41.7
 Manganese Sulfate Precipitator:			
-----			
Incoming Waste Arsenic Content (ppm)	100 - 1,000	205	
Untreated Waste pH	11.2 - 11.5	12.41	
Amount of Chemical Treatment Added (lbs)	495	495	
Molar Ratio of Treatment Chemical to Arsenic	1.2:1 - 12:1	7.0	
Mixing Time (min)	30	30	
Amount of Flocculant Added (gal)	3 - 5	5	
Waste Volume (gal)	16,200	15,400	
Treated Waste pH	8.0 - 8.5	7.34	
Reaction Temperature ( °C)	Ambient	30.9	
 Ferric Sulfate Precipitator:			
-----			
Incoming Waste Arsenic Content (ppm)	10 - 100	15.0	
Untreated Waste pH	8.0 - 8.5	7.17	
Amount of Chemical Treatment Added (lbs)	50 lbs/10 ppm* Arsenic	100	
Molar Ratio of Treatment Chemical to Arsenic	9:1	13.3	
Mixing Time (min)	30	30	
Amount of Flocculant Added (gal)	3 - 5	5	
Waste Volume (gal)	16,000	16,200	
Treated Waste pH	4.4 - 4.6	4.00	
Reaction Temperature ( °C)	Ambient	29.2	

\*Plant experience is normally used in chemical addition with color of incoming waste being the indicator.  
a - Obtained from Onsite Engineering Report for Salsbury Laboratories for D004, Tables 3-1 through 3-3.

TABLE 3-22 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF D004 BY CHEMICAL PRECIPITATION <sup>a</sup>SAMPLE SET 4

	UNTREATED WASTE		TREATED WASTE
	Basin #5	Basin #6	
<hr/>			
<u>BDAT LIST</u>			
Metals (mg/l)			
154 Antimony	1.590	3.160	<0.640
155 Arsenic	1,340	399	0.418
156 Barium	0.270	0.251	0.035
157 Beryllium	<0.020	<0.020	<0.020
158 Cadmium	2.860	0.977	<0.080
159 Chromium	<0.140	<0.140	<0.140
160 Copper	<0.120	<0.120	0.240
161 Lead	0.478	<0.050	<0.010
162 Mercury	0.076	0.040	0.0039
163 Nickel	<0.220	<0.220	<0.220
164 Selenium	<0.025	<0.025	<0.050
165 Silver	<0.120	<0.120	<0.120
166 Thallium	<10	<0.010	<0.010
167 Vanadium	<0.120	<0.120	<0.120
168 Zinc	0.210	0.636	0.743

Continued

TABLE 3-22 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF D004 BY CHEMICAL PRECIPITATION <sup>a</sup>  
(Continued)

SAMPLE SET 4

OPERATING PARAMETERS	DESIGN VALUE	OPERATING RANGE	
<hr/>			
Calcium Hydroxide Precipitator:		Basin #5	Basin #6
-----		-----	-----
Incoming Waste Arsenic Content (ppm)	500 - 5,000	1,340	399
Untreated Waste pH	2 - 8	6.46	12.12
Molar Ratio of Treatment Chemical to Arsenic	1.5:1 Min.	2.2	5.8
Mixing Time (min)	15 - 30	25	20
Amount of Flocculant Added (gal)	2 - 5	3	5
Waste Volume (gal)	8,000	7,280	7,130
Treated Waste pH	11.2 - 11.5	11.84	12.86
Reaction Temperature (°C)	Ambient	30.7	26.7
 Manganese Sulfate Precipitator:			
-----			
Incoming Waste Arsenic Content (ppm)	100 - 1,000		125
Untreated Waste pH	11.2 - 11.5		12.35
Amount of Chemical Treatment Added (lbs)	495		495
Molar Ratio of Treatment Chemical to Arsenic	1.2:1 - 12:1		10.3
Mixing Time (min)	30		35
Amount of Flocculant Added (gal)	3 - 5		3
Waste Volume (gal)	16,200		17,500
Treated Waste pH	8.0 - 8.5		7.49
Reaction Temperature (°C)	Ambient		26.8
 Ferric Sulfate Precipitator:			
-----			
Incoming Waste Arsenic Content (ppm)	10 - 100		26.5
Untreated Waste pH	8.0 - 8.5		7.49
Amount of Chemical Treatment Added (lbs)	50 lbs/10 ppm* Arsenic		100
Molar Ratio of Treatment Chemical to Arsenic	9:1		7.2
Mixing Time (min)	30		35
Amount of Flocculant Added (gal)	3 - 5		5
Waste Volume (gal)	16,000		17,000
Treated Waste pH	4.4 - 4.6		4.12
Reaction Temperature (°C)	Ambient		26.2

\*Plant experience is normally used in chemical addition with color of incoming waste being the indicator.

a - Obtained from Onsite Engineering Report for Salsbury Laboratories for D004, Tables 3-1 through 3-3.

TABLE 3-23 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF D004 BY CHEMICAL PRECIPITATION <sup>a</sup>SAMPLE SET 5

	UNTREATED WASTE		TREATED WASTE
	Basin #5	Basin #6	
<hr/>			
<u>BDAT LIST</u>			
Metals (mg/l)			
154 Antimony	0.640	3.410	<0.640
155 Arsenic	1,670	717	0.440
156 Barium	0.509	0.226	0.037
157 Beryllium	<0.020	<0.020	<0.020
158 Cadmium	3.640	1.500	<0.080
159 Chromium	<0.140	<0.140	<0.140
160 Copper	<0.120	<0.120	0.506
161 Lead	0.371	0.197	<0.025
162 Mercury	0.0034	0.139	0.0061
163 Nickel	<0.22 <sup>33</sup>	<0.220	<0.220
164 Selenium	<0.025	<0.025	<0.100
165 Silver	<0.120	<0.120	<0.120
166 Thallium	<10	<10	<0.010
167 Vanadium	<0.120	<0.120	<0.120
168 Zinc	0.164	0.974	1.710

Continued



TABLE 3-23 ANALYTICAL RESULTS AND OPERATING DATA FOR TREATMENT OF D004 BY CHEMICAL PRECIPITATION <sup>a</sup>  
(Continued)

SAMPLE SET 5

OPERATING PARAMETERS	DESIGN VALUE	OPERATING RANGE	
Calcium Hydroxide Precipitator:		Basin #5	Basin #6
-----		-----	-----
Incoming Waste Arsenic Content (ppm)	500 - 5,000	1,670	717
Untreated Waste pH	2 - 8	1.79**	6.97
Molar Ratio of Treatment Chemical to Arsenic	1.5:1 Min.	1.3	2.1
Mixing Time (min)	15 - 30	25	30
Amount of Flocculant Added (gal)	2 - 5	3	5
Waste Volume (gal)	8,000	7,280	7,130
Treated Waste pH	11.2 - 11.5	12.02	11.86
Reaction Temperature (°C)	Ambient	20.0	48.0
Manganese Sulfate Precipitator:			
-----			
Incoming Waste Arsenic Content (ppm)	100 - 1,000		302
Untreated Waste pH	11.2 - 11.5		11.93
Amount of Chemical Treatment Added (lbs)	495		495
Molar Ratio of Treatment Chemical to Arsenic	1.2:1 - 12:1		4.7
Mixing Time (min)	30		30
Amount of Flocculant Added (gal)	3 - 5		5
Waste Volume (gal)	16,200		15,700
Treated Waste pH	8.0 - 8.5		7.02
Reaction Temperature (°C)	Ambient		33.7
Ferric Sulfate Precipitator:			
-----			
Incoming Waste Arsenic Content (ppm)	10 - 100		107.0
Untreated Waste pH	8.0 - 8.5		7.34
Amount of Chemical Treatment Added (lbs)	50 lbs/10 ppm* Arsenic		250
Molar Ratio of Treatment Chemical to Arsenic	9:1		4.7
Mixing Time (min)	30		40
Amount of Flocculant Added (gal)	3 - 5		5
Waste Volume (gal)	16,000		16,000
Treated Waste pH	4.4 - 4.6		3.91
Reaction Temperature (°C)	Ambient		31.5

\*Plant experience is normally used in chemical addition with color of incoming waste being the indicator.

\*\*This value was measured on a sample taken directly from the feed line to the basin.

a - Obtained from Onsite Engineering Report for Salsbury Laboratories for D004, Tables 3-1 through 3-3.

#### 4. IDENTIFICATION OF BEST DEMONSTRATED AVAILABLE TREATMENT TECHNOLOGY FOR K101 AND K102

This section describes how the data collected by the Agency was evaluated to determine which demonstrated treatment technology system represents BDAT for waste codes K101 and K102. The previous section described applicable and demonstrated treatment technologies for waste codes K101 and K102, and the available performance data for these technologies. The demonstrated treatment technology under consideration for nonwastewaters is rotary kiln incineration and metals stabilization of the kiln ash. The demonstrated treatment technology under consideration for wastewaters is chemical precipitation and metals stabilization of the nonwastewater precipitate. As discussed in Section 3, the Agency collected performance data for the treatment of K101 and K102 nonwastewaters from one treatment technology system: rotary kiln incineration. No additional performance data were available for the treatment of K101 and K102 wastewaters or nonwastewaters.

The topics covered in this section include descriptions of the data screening process employed, the methods used to ensure accuracy of the analytical data, and the analysis of variance (ANOVA) tests performed in identifying the best technology for the treatment of K101 and K102 wastes.

In general, performance data are screened according to the following three conditions:

- o proper design and operation of the treatment system;
- o the existence of quality assurance/quality control measures in the data analysis; and
- o the use of proper analytical tests in assessing treatment performance.

Sets of performance data which do not meet these three conditions are not considered in the selection of BDAT. In addition, if performance data indicate that the treatment system was not well-designed and well-operated at the time of testing, these data would also not be used.

The remaining performance data are then corrected to account for incomplete recovery of certain constituents during the analyses. Finally, in cases where the Agency has adequate performance data for treatment of the waste by more than one technology, an analysis of variance (ANOVA) test is used to select the best treatment technology.

#### 4.1 Review of Performance Data

##### 4.1.1 Nonwastewaters

Six data sets were collected by the Agency for treatment of waste code K102 and four data sets were collected by the Agency for treatment of K101, both by rotary kiln incineration. These

data sets are provided in Tables 3-1 through 3-12 in the preceding section. The data sets were evaluated to determine whether any of the data represented poor design or operation of the treatment systems. None of the data sets were deleted after evaluation. Of the six data sets in K102, insufficient ash was generated for sample sets 5 and 6. No ash was generated out of the four data sets in K101. Therefore, three ash samples from the kiln walls were substituted for the treated waste samples in K101. Insufficient ash was generated during the incineration of K101 and K102, therefore, stabilization of the ash could not be performed. In addition, no performance data were available for treatment of the resulting scrubber water.

Performance data were not collected for metals stabilization of the incinerator ash or the scrubber water precipitate for K101 and K102. The Agency will, therefore, consider performance data for K101 and K102 which has been transferred from similar wastes based on waste characteristics affecting performance. The available data collected by the Agency for F006 was used as performance data for stabilization of the K101 and K102 incinerator ash and precipitate residuals. These data were evaluated to determine whether any of the data represented poor design or operation of the system. Nine of the available data sets were used for the development of treatment standards for nonwastewaters from K101 and K102.

Performance data for stabilization of the kiln ash can be found in the Background Document for F006.

#### 4.1.2 Wastewaters

Performance data was not collected for chemical precipitation of K101 and K102 wastewaters. Five data sets from the treatment of D004 were collected by the Agency for chemical precipitation. The five data sets for D004 were transferred to the resulting K101 and K102 scrubber water based on waste characteristics affecting performance. None of the data sets in D004 were deleted due to poor design or operation of the treatment system during the time data were being collected. Performance data for chemical precipitation of the scrubber waters can be found in the Onsite Engineering Report for waste characterized as EPA hazardous waste number, D004.

#### 4.2 Accuracy Correction of Performance Data

After data were eliminated from consideration for analysis of BDAT based on the screening tests, the Agency adjusted the data using analytical recovery values. Recovery values take into account analytical interferences and incomplete recoveries associated with the chemical makeup of the sample. The recovery values are listed in Appendix B. The Agency developed the recovery data (also referred to as accuracy data), by first

analyzing a waste for a given constituent and then adding a known amount of the same constituent (i.e., spike) to the waste material. The total amount recovered after spiking, minus the initial concentration in the sample, divided by the amount added, is the recovery value. At least two recovery values were calculated for spiked constituents, and the analytical data were adjusted for accuracy using the lowest recovery value for each constituent. This was accomplished by calculating an accuracy factor from the percent recoveries for each selected constituent. The reciprocal of the lower of the two recovery values multiplied by 100, yields the accuracy factor. The corrected concentration for each sample set is obtained by multiplying the accuracy factor by the raw data value. Should the corrected value be lower than the detection limit<sup>1</sup>, the detection limit value is substituted for the corrected value.

In instances where a selected constituent was not detected in the treated waste, the treated value for that constituent was assumed to be the detection limit. The detection limit is corrected in the same manner as described above with one exception: the detection limit is not corrected to a value lower than the detection limit. The EPA does not consider values lower

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1. A detection limit is defined as the practical quantification limit, PQL, that is five times the method detection limit achievable when using an EPA-approved analytical method specified for a particular analysis (i.e., constituent of interest) in SW-846, 3rd Edition (USEPA 1986a).

than the detection limit to be valid. The recovery values used and accuracy factors calculated for the selected constituents are presented in Appendix D.

An arithmetic average value, representing the treated waste concentration, was calculated for each selected constituent from the corrected values. The accuracy corrected data, averages and variability factors are presented in Tables 6-1 and 6-2 for nonwastewaters and in Table 6-3 for wastewaters. These adjusted values for the treatment technology systems consisting of rotary kiln incineration followed by stabilization of the kiln ash and chemical precipitation of the scrubber water followed by stabilization of the precipitate were then used to determine BDAT for waste codes K101 and K102.

#### 4.3 Statistical Comparison of Performance Data

In cases where the Agency has adequate performance data on treatment of the same or similar wastes using more than one technology, an analysis of variance (ANOVA) test is performed to determine if one of the technologies provides significantly the best treatment compared to the others. In cases where a particular treatment technology is shown to provide the best treatment, the treatment standards will be based on this best technology.

#### 4.4 BDAT for K101/K102 Wastes

In the case of K101 and K102 wastes, the Agency does not have performance data for any demonstrated technology beyond rotary kiln incineration followed by stabilization of the kiln ash and chemical precipitation of the scrubber water followed by stabilization of the precipitate. The Agency therefore has no reason to believe that the levels of performance achieved by this technology can be improved upon. Thus, the Agency has determined that performance achieved by incineration followed by stabilization of the kiln ash and chemical precipitation of the scrubber water followed by stabilization of the precipitate represents BDAT.

Rotary kiln incineration and metals stabilization is judged to be available to treat K101 and K102 nonwastewaters. Chemical precipitation is judged to be available to treat K101 and K102 wastewaters.

The Agency believes these technologies to be available because: (1) these technologies are commercially available; and (2) these technologies provide a substantial reduction in the leachable levels of BDAT list constituents present in waste K101 and K102.



## 5. SELECTION OF REGULATED CONSTITUENTS

In the previous section, the best demonstrated available technology (BDAT) for treating waste codes K101 and K102 was determined to be incineration followed by metals stabilization of the kiln ash and chemical precipitation of the scrubber water followed by metals stabilization of the precipitate. In this section, the necessary constituents are identified for assuring the most effective treatment of the waste. This is done by following a three-step procedure:

- o identifying the BDAT list constituents found in both the untreated and treated waste;
- o evaluating effectiveness of the treatment, and
- o selecting the regulated constituents.

As discussed in Section 1, the Agency has developed a target list of hazardous constituents (Table 1-1) from which the constituents to be regulated are selected. The list is a "growing list" that does not preclude the addition of new constituents as additional key parameters are identified. The list is divided into the following categories: volatile organics, semivolatile organics, metals, inorganics other than metals, organochlorine pesticides, phenoxyacetic acid herbicides, organophosphorous pesticides, PCBS, and dioxins and furans.

## 5.1 BDAT List Constituents Detected in the Untreated and Treated Waste

Using EPA-collected data, the Agency identified those constituents that were detected in the untreated waste and the waste treated by incineration. EPA collected four sets of data at one facility for waste code K101 (see the Onsite Engineering Report for K101 for more details) to evaluate the treatment of waste code K101 by incineration.<sup>1</sup> All four data sets were used to identify the constituents detected in the untreated waste and three ash samples were used to identify constituents in the treated waste. EPA also collected six sets of data at this facility for waste code K102 (see the Onsite Engineering Report for K102 for more details) to evaluate the treatment of waste code K102 by incineration.<sup>1</sup> All six data sets were used to identify the constituents detected in the untreated waste, and four of the six data sets were used to identify constituents detected in the treated waste. The detection limits for the BDAT list of constituents for K101 and K102 are presented in Appendix C.

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1. Data for stabilization of kiln ash and scrubber water precipitate will be transferred from the treatment of EPA hazardous waste number, F006. Data for chemical precipitation of the scrubber waters will be transferred from the treatment of EPA hazardous waste number, D004 (wastes which exhibited characteristics for EP toxicity for arsenic).

Tables 5-1 and 5-2 presents the BDAT list as discussed in Section 1. It indicates which of the BDAT list constituents were analyzed in the untreated and treated waste for K101 and K102.

As shown in Table 5-1, the following constituents were detected in the untreated waste K101: acetone, toluene, 2-nitroaniline, antimony, arsenic, barium, chromium, copper, lead, mercury, nickel, silver, vanadium, zinc, fluoride, and sulfide. The following constituents were detected after incineration of the K101 waste in the kiln ash: antimony, arsenic, barium, beryllium, chromium, copper, lead, nickel, silver, vanadium, zinc, and sulfide.

The following constituents were detected in the scrubber waters generated from incineration: bis(2-ethylhexyl) phthalate, antimony, arsenic, barium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, vanadium, and zinc.

As shown in Table 5-2, the following constituents were detected in the untreated waste K102: toluene, 2-nitrophenol, total xylenes, antimony, arsenic, barium, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, thallium, vanadium, zinc, cyanide, fluoride, and sulfide. The following constituents were detected in the kiln ash after incineration of in the K102 waste: antimony, arsenic, barium, cadmium, chromium,

TABLE 5-1 BDAT List Constituents in Untreated and Treated K101 Waste <sup>a</sup>

Parameter	Untreated	Treated K101		Scrubber
	K101 (mg/kg)	Total (mg/kg)	TCLP (mg/l)	Wastewater (mg/l)
<u>Volatiles</u>				
222 Acetone	D	D	NA	ND
1 Acetonitrile	ND	ND	NA	ND
2 Acrolein	ND	ND	NA	ND
3 Acrylonitrile	ND	ND	NA	ND
4 Benzene	ND	ND	NA	ND
5 Bromodichloromethane	ND	ND	NA	ND
6 Bromomethane	ND	ND	NA	ND
223 n-Butyl alcohol	NA	NA	NA	NA
7 Carbon Tetrachloride	ND	ND	NA	ND
8 Carbon disulfide	ND	ND	NA	ND
9 Chlorobenzene	ND	ND	NA	ND
10 2-Chloro-1,3-butadiene	ND	ND	NA	ND
11 Chlorodibromomethane	ND	ND	NA	ND
12 Chloroethane	ND	ND	NA	ND
13 2-Chloroethyl vinyl ether	ND	ND	NA	ND
14 Chloroform	ND	ND	NA	ND
15 Chloromethane	ND	ND	NA	ND
16 3-Chloropropene	ND	ND	NA	ND
17 1,2-Dibromo-3-chloropropane	ND	ND	NA	ND
18 1,2-Dibromoethane	ND	ND	NA	ND
19 Dibromomethane	ND	ND	NA	ND
20 trans-1,4-Dichloro-2-butene	ND	ND	NA	ND
21 Dichlorodifluoromethane	ND	ND	NA	ND
22 1,1-Dichloroethene	ND	ND	NA	ND
23 1,2-Dichloroethane	ND	ND	NA	ND
24 1,1-Dichloroethylene	ND	ND	NA	ND
25 trans-1,2-Dichloroethene	ND	ND	NA	ND
26 1,2-Dichloropropane	ND	ND	NA	ND
27 trans-1,3-Dichloropropene	ND	ND	NA	ND
28 cis-1,3-Dichloropropene	ND	ND	NA	ND
29 1,4-Dioxane	ND	ND	NA	ND
224 2-Ethoxyethanol	NA	NA	NA	NA
225 Ethyl acetate	NA	NA	NA	NA
226 Ethyl benzene	ND	ND	NA	ND
30 Ethyl cyanide	ND	ND	NA	ND
227 Ethyl ether	NA	NA	NA	NA
31 Ethyl methacrylate	ND	ND	NA	ND
214 Ethylene oxide	ND	ND	NA	ND
32 Iodomethane	ND	ND	NA	ND

D - This constituent was detected.

NA - This constituent was not analyzed.

ND - This constituent was not detected.

Continued

TABLE 5-1 BDAT List Constituents in Untreated and Treated K101 Waste <sup>a</sup> (Continued)

Parameter	Untreated	Treated K101		Scrubber Wastewater
	K101 (mg/kg)	Total (mg/kg)	TCLP (mg/l)	
<u>Volatiles (continued)</u>				
33 Isobutyl alcohol	ND	ND	NA	ND
228 Methanol	NA	NA	NA	NA
34 Methyl ethyl ketone	ND	ND	NA	ND
229 Methyl isobutyl ketone	NA	NA	NA	NA
35 Methyl methacrylate	ND	ND	NA	ND
37 Methylacrylonitrile	ND	ND	NA	ND
38 Methylene chloride	ND	ND	NA	ND
230 2-Nitropropane	NA	NA	NA	NA
39 Pyridine	ND	ND	NA	ND
40 1,1,1,2-Tetrachloroethane	ND	ND	NA	ND
41 1,1,2,2-Tetrachloroethane	ND	ND	NA	ND
42 Tetrachloroethene	ND	ND	NA	ND
43 Toluene	D	ND	NA	ND
44 Tribromomethane	ND	ND	NA	ND
45 1,1,1-Trichloroethane	ND	ND	NA	ND
46 1,1,2-Trichloroethane	ND	ND	NA	ND
47 Trichloroethene	ND	ND	NA	ND
48 Trichloromonofluoromethane	ND	ND	NA	ND
49 1,2,3-Trichloropropane	ND	ND	NA	ND
231 1,1,2-Trichloro-1,2,2-trifluoroethane	NA	NA	NA	NA
50 Vinyl chloride	ND	ND	NA	ND
215 1,2-Xylene	NA	NA	NA	NA
216 1,3-Xylene	NA	NA	NA	NA
217 1,4-Xylene	NA	NA	NA	NA
<u>Semivolatiles</u>				
51 Acenaphthalene	ND	ND	NA	ND
52 Acenaphthene	ND	ND	NA	ND
53 Acetophenone	ND	ND	NA	ND
54 2-Acetylaminofluorene	ND	ND	NA	ND
55 4-Aminobiphenyl	ND	ND	NA	ND
56 Aniline	ND	ND	NA	ND
57 Anthracene	ND	ND	NA	ND
58 Aramite	NA	NA	NA	NA
59 Benz(a)anthracene	ND	ND	NA	ND
218 Benzal chloride	NA	NA	NA	NA
60 Benzenethiol	ND	ND	NA	ND
61 Benzidine	ND	ND	NA	ND
62 Benzo(a)pyrene	ND	ND	NA	ND

D - This constituent was detected.

NA - This constituent was not analyzed.

ND - This constituent was not detected.

Continued

TABLE 5-1 BDAT List Constituents in Untreated and Treated K101 Waste <sup>a</sup> (Continued)

Parameter	Untreated	Treated K101		Scrubber Wastewater
	K101 (mg/kg)	Total (mg/kg)	TCLP (mg/L)	
<u>Semivolatiles (continued)</u>				
63 Benzo(b)fluoranthene	ND	ND	NA	ND
64 Benzo(ghi)perylene	ND	ND	NA	ND
65 Benzo(k)fluoranthene	ND	ND	NA	ND
66 p-Benzoquinone	ND	ND	NA	ND
67 Bis(2-chloroethoxy)ethane	ND	ND	NA	ND
68 Bis(2-chloroethyl)ether	ND	ND	NA	ND
69 Bis(2-chloroisopropyl)ether	ND	ND	NA	ND
70 Bis(2-ethylhexyl)phthalate	ND	ND	NA	D
71 4-Bromophenyl phenyl ether	ND	ND	NA	ND
72 Butyl benzyl phthlate	ND	ND	NA	ND
73 2-sec-Butyl-4,6-dinitrophenol	ND	ND	NA	ND
74 p-Chloroaniline	ND	ND	NA	ND
75 Chlorobenzilate	NA	NA	NA	NA
76 p-Chloro-m-cresol	ND	ND	NA	ND
77 2-Chloronaphthalene	ND	ND	NA	ND
78 2-Chlorophenol	ND	ND	NA	ND
79 3-Chloropropionitrile	NA	NA	NA	NA
80 Chrysene	ND	ND	NA	ND
81 ortho-Cresol	ND	ND	NA	ND
82 para-Cresol	ND	ND	NA	ND
232 Cyclohexanone	ND	ND	NA	ND
83 Dibenz(a,h)anthracene	ND	ND	NA	ND
84 Dibenzo(a,e)pyrene	NA	NA	NA	NA
85 Dibenzo(a,i)pyrene	NA	NA	NA	NA
86 m-Dichlorobenzene	ND	ND	NA	ND
87 o-Dichlorobenzene	ND	ND	NA	ND
88 p-Dichlorobenzene	ND	ND	NA	ND
89 3,3'-Dichlorobenzidine	ND	ND	NA	ND
90 2,4-Dichlorophenol	ND	ND	NA	ND
91 2,6-Dichlorophenol	ND	ND	NA	ND
92 Diethyl phthalate	ND	ND	NA	ND
93 3,3'-Dimethoxylbenzidine	ND	ND	NA	ND
94 p-Dimethylaminoazobenzene	ND	ND	NA	ND
95 3,3'-Dimethylbenzidine	ND	ND	NA	ND
96 2,4-Dimethylphenol	ND	ND	NA	ND
97 Dimethyl phthalate	ND	ND	NA	ND
98 Di-n-butyl phthalate	ND	ND	NA	ND
99 1,4-Dinitrobenzene	ND	ND	NA	ND
100 4,6-Dinitro-o-cresol	ND	ND	NA	ND
101 2,4-Dinitrophenol	ND	ND	NA	ND

D - This constituent was detected.

NA - This constituent was not analyzed.

ND - This constituent was not detected.

Continued

TABLE 5-1 BDAT List Constituents in Untreated and Treated K101 Waste <sup>a</sup> (Continued)

Parameter	Untreated	Treated K101		Scrubber Wastewater (mg/L)
	K101 (mg/kg)	Total (mg/kg)	TCLP (mg/L)	
<u>Semivolatiles (cont.)</u>				
102 2,4-Dinitrotoluene	ND	ND	NA	ND
103 2,6-Dinitrotoluene	ND	ND	NA	ND
104 Di-n-octyl phthalate	ND	ND	NA	ND
105 Di-n-propylnitrosamine	ND	ND	NA	ND
106 Diphenylamine	ND	ND	NA	ND
219 Diphenylnitrosamine	NA	NA	NA	NA
107 1,2-Diphenylhydrazine	ND	ND	NA	ND
108 Fluoranthene	ND	ND	NA	ND
109 Fluorene	ND	ND	NA	ND
110 Hexachlorobenzene	ND	ND	NA	ND
111 Hexachlorobutadiene	ND	ND	NA	ND
112 Hexachlorocyclopentadiene	ND	ND	NA	ND
113 Hexachloroethane	ND	ND	NA	ND
114 Hexachlorophene	NA	NA	NA	NA
115 Hexachloropropene	ND	ND	NA	ND
116 Indeno(1,2,3-cd)pyrene	ND	ND	NA	ND
117 Isosafrole	ND	ND	NA	ND
118 Methapyrilene	NA	NA	NA	NA
119 3-Methycholanthrene	ND	ND	NA	ND
120 4,4'-Methylenebis(2-chloroaniline)	ND	ND	NA	ND
36 Methyl methanesulfonate	ND	ND	NA	ND
121 Napthalene	ND	ND	NA	ND
122 1,4-Naphthoquinone	NA	NA	NA	NA
123 1-Napthylamine	ND	ND	NA	ND
124 2-Napthylamine	ND	ND	NA	ND
*** 2-Nitroaniline	D	ND	NA	ND
125 p-Nitroaniline	ND	ND	NA	ND
126 Nitrobenzene	ND	ND	NA	ND
127 4-Nitrophenol	ND	ND	NA	ND
128 N-Nitrosodi-n-butylamine	ND	ND	NA	ND
129 N-Nitrosodiethylamine	ND	ND	NA	ND
130 N-Nitrosodimethylamine	ND	ND	NA	ND
131 N-Nitrosomethylethylamine	ND	ND	NA	ND
132 N-Nitrosomorpholine	ND	ND	NA	ND
133 N-Nitrosopiperidine	ND	ND	NA	ND
134 N-Nitrosopyrrolidine	ND	ND	NA	ND
135 5-Nitro-o-toluidine	ND	ND	NA	ND
136 Pentachlorobenzene	ND	ND	NA	ND
137 Pentachloroethane	NA	NA	NA	NA
138 Pentachloronitrobenzene	ND	ND	NA	ND

\*\*\*- Not on BDAT List.

D - This constituent was detected.

NA - This constituent was not analyzed.

ND - This constituent was not detected.

Continued

TABLE 5-1 BDAT List Constituents in Untreated and Treated K101 Waste <sup>a</sup> (Continued)

Parameter	Untreated K101 (mg/kg)	Treated K101 Total (mg/kg)	TCLP (mg/l)	Scrubber Wastewater (mg/l)
<u>Semivolatiles (cont.)</u>				
139 Pentachlorophenol	ND	ND	NA	ND
140 Phenacetin	ND	ND	NA	ND
141 Phenanthrene	ND	ND	NA	ND
142 Phenol	ND	ND	NA	ND
220 Phthalic anhydride	ND	ND	NA	ND
143 2-Picoline	ND	ND	NA	ND
144 Pronamide	ND	ND	NA	ND
145 Pyrene	ND	ND	NA	ND
146 Resorcinol	NA	NA	NA	NA
147 Safrole	ND	ND	NA	ND
148 1,2,4,5-Tetrachlorobenzene	ND	ND	NA	ND
149 2,3,4,6-Tetrachlorophenol	ND	ND	NA	ND
150 1,2,4-Trichlorobenzene	ND	ND	NA	ND
151 2,4,5-Trichlorophenol	ND	ND	NA	ND
152 2,4,6-Trichlorophenol	ND	ND	NA	ND
153 Tris(2,3-dibromopropyl)phosphate	ND	ND	NA	ND
<u>Metals</u>				
154 Antimony	D	D	D	D
155 Arsenic	D	D	D	D
156 Barium	D	D	D	D
157 Beryllium	ND	D	D	ND
158 Cadmium	ND	ND	D	ND
159 Chromium	D	D	D	D
221 Chromium (hexavalent)	ND	ND	ND	ND
160 Copper	D	D	D	D
161 Lead	D	D	D	D
162 Mercury	D	ND	ND	D
163 Nickel	D	D	D	D
164 Selenium	ND	ND	ND	D
165 Silver	D	D	ND	D
166 Thallium	ND	ND	ND	D
167 Vanadium	D	D	D	D
168 Zinc	D	D	D	D
<u>Inorganics</u>				
169 Cyanide	ND	ND	NA	ND
170 Fluoride	D**	D	NA	D**
171 Sulfide	D	D	NA	D

D - This constituent was detected.

NA - This constituent was not analyzed.

ND - This constituent was not detected.

\*\* - Indicates that only sample set 3 was analyzed for this constituent.

Continued



TABLE 5-1 BDAT List Constituents in Untreated and Treated K101 Waste <sup>a</sup> (Continued)

Parameter	Untreated	Treated K101		Scrubber Wastewater
	K101 (mg/kg)	Total (mg/kg)	TCLP (mg/L)	
<u>Organochlorine Pesticides</u>				
172 Aldrin	NA	NA	NA	NA
173 alpha-BHC	NA	NA	NA	NA
174 beta-BHC	NA	NA	NA	NA
175 delta-BHC	NA	NA	NA	NA
176 gamma-BHC	NA	NA	NA	NA
177 Chlordane	NA	NA	NA	NA
178 DDD	NA	NA	NA	NA
179 DDE	NA	NA	NA	NA
180 DDT	NA	NA	NA	NA
181 Dieldrin	NA	NA	NA	NA
182 Endosulfan I	NA	NA	NA	NA
183 Endosulfan II	NA	NA	NA	NA
184 Endrin	NA	NA	NA	NA
185 Endrin aldehyde	NA	NA	NA	NA
186 Heptachlor	NA	NA	NA	NA
187 Heptachlor epoxide	NA	NA	NA	NA
188 Isodrin	NA	NA	NA	NA
189 Kepone	NA	NA	NA	NA
190 Mehoxychlor	NA	NA	NA	NA
191 Toxaphene	NA	NA	NA	NA
<u>Phenoxyacetic Acid Herbicides</u>				
192 2,4-Dichlorophenoxyacetic acid	NA	NA	NA	NA
193 Silvex	NA	NA	NA	NA
194 2,4,5-T	NA	NA	NA	NA
<u>Organophosphorous Insecticides</u>				
195 Disulfoton	NA	NA	NA	NA
196 Famphur	NA	NA	NA	NA
197 Methyl parathion	NA	NA	NA	NA
198 Paration	NA	NA	NA	NA
199 Phorate	NA	NA	NA	NA
<u>PCBs**</u>				
200 Aroclor 1016	ND	ND	NA	ND
201 Aroclor 1221	ND	ND	NA	ND
202 Aroclor 1232	ND	ND	NA	ND

NA - This constituent was not analyzed.

ND - This constituent was not detected.

Continued

TABLE 5-1 BDAT List Constituents in Untreated and Treated K101 Waste <sup>a</sup> (Continued)

Parameter	Untreated K101 (mg/kg)	Treated K101 Total (mg/kg)	TCLP (mg/l)	Scrubber Wastewater (mg/l)
<u>PCBs** (continued)</u>				
203 Aroclor 1242	ND	ND	NA	ND
204 Aroclor 1248	ND	ND	NA	ND
205 Aroclor 1254	ND	ND	NA	ND
206 Aroclor 1260	ND	ND	NA	ND
<u>Dioxins and Furans**</u>				
207 Hexachlorodibenzo-p-dioxins	ND	ND	NA	ND
208 Hexachlorodibenzofuran	ND	ND	NA	ND
209 Pentachlorodibenzo-p-dioxins	ND	ND	NA	ND
210 Pentachlorodibenzofuran	ND	ND	NA	ND
211 Tetrachlorodibenzo-p-dioxins	ND	ND	NA	ND
212 Tetrachlorodibenzofuran	ND	ND	NA	ND
213 2,3,7,8-Tetrachlorodibenzo-p-dioxin	ND	ND	NA	ND

a - Obtained from Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K101.

Tables 5-2 through 5-7.

NA - This constituent was not analyzed.

ND - This constituent was not detected.

TABLE 5-2 BDAT List Constituents in Untreated and Treated K102 Waste <sup>a</sup>

Parameter	Untreated	Treated K102		Scrubber
	K102 (mg/kg)	Total (mg/kg)	TCLP (mg/l)	Wastewater (mg/l)
<u>Volatiles</u>				
222 Acetone	ND	ND	NA	ND
1 Acetonitrile	ND	ND	NA	ND
2 Acrolein	ND	ND	NA	ND
3 Acrylonitrile	ND	ND	NA	ND
4 Benzene	ND	ND	NA	ND
5 Bromodichloromethane	ND	ND	NA	ND
6 Bromomethane	ND	ND	NA	ND
223 n-Butyl alcohol	NA	NA	NA	NA
7 Carbon Tetrachloride	ND	ND	NA	ND
8 Carbon disulfide	ND	ND	NA	ND
9 Chlorobenzene	ND	ND	NA	ND
10 2-Chloro-1,3-butadiene	ND	ND	NA	ND
11 Chlorodibromomethane	ND	ND	NA	ND
12 Chloroethane	ND	ND	NA	ND
13 2-Chloroethyl vinyl ether	ND	ND	NA	ND
14 Chloroform	ND	ND	NA	ND
15 Chloromethane	ND	ND	NA	ND
16 3-Chloropropene	ND	ND	NA	ND
17 1,2-Dibromo-3-chloropropane	ND	ND	NA	ND
18 1,2-Dibromoethane	ND	ND	NA	ND
19 Dibromomethane	ND	ND	NA	ND
20 trans-1,4-Dichloro-2-butene	ND	ND	NA	ND
21 Dichlorodifluoromethane	ND	ND	NA	ND
22 1,1-Dichloroethene	ND	ND	NA	ND
23 1,2-Dichloroethane	ND	ND	NA	ND
24 1,1-Dichloroethylene	ND	ND	NA	ND
25 trans-1,2-Dichloroethene	ND	ND	NA	ND
26 1,2-Dichloropropane	ND	ND	NA	ND
27 trans-1,3-Dichloropropene	ND	ND	NA	ND
28 cis-1,3-Dichloropropene	ND	ND	NA	ND
29 1,4-Dioxane	ND	ND	NA	ND
224 2-Ethoxyethanol	NA	NA	NA	NA
225 Ethyl acetate	NA	NA	NA	NA
226 Ethyl benzene	ND	ND	NA	ND
30 Ethyl cyanide	ND	ND	NA	ND
227 Ethyl ether	NA	NA	NA	NA
31 Ethyl methacrylate	ND	ND	NA	ND
214 Ethylene oxide	ND	ND	NA	ND
32 Iodomethane	ND	ND	NA	ND

NA - This constituent was not analyzed.

ND - This constituent was not detected.

Continued

TABLE 5-2 BDAT List Constituents in Untreated and Treated K102 Waste <sup>a</sup> (Continued)

Parameter	Untreated	Treated K102		Scrubber
	K102 (mg/kg)	Total (mg/kg)	TCLP (mg/L)	Wastewater (mg/L)
<u>Volatiles</u> (continued)				
33 Isobutyl alcohol	ND	ND	NA	ND
228 Methanol	NA	NA	NA	NA
34 Methyl ethyl ketone	ND	ND	NA	ND
229 Methyl isobutyl ketone	NA	NA	NA	NA
35 Methyl methacrylate	ND	ND	NA	ND
37 Methylacrylonitrile	ND	ND	NA	ND
38 Methylene chloride	ND	ND	NA	ND
230 2-Nitropropane	NA	NA	NA	NA
39 Pyridine	ND	ND	NA	ND
40 1,1,1,2-Tetrachloroethane	ND	ND	NA	ND
41 1,1,2,2-Tetrachloroethane	ND	ND	NA	ND
42 Tetrachloroethene	ND	ND	NA	ND
43 Toluene	D	ND	NA	ND
44 Tribromomethane	ND	ND	NA	ND
45 1,1,1-Trichloroethane	ND	ND	NA	ND
46 1,1,2-Trichloroethane	ND	ND	NA	ND
47 Trichloroethene	ND	ND	NA	ND
48 Trichloromonofluoromethane	ND	ND	NA	ND
49 1,2,3-Trichloropropane	ND	ND	NA	ND
231 1,1,2-Trichloro-1,2,2-trifluoroethane	NA	NA	NA	NA
50 Vinyl chloride	ND	ND	NA	ND
215 1,2-Xylene	NA	NA	NA	NA
216 1,3-Xylene	NA	NA	NA	NA
217 1,4-Xylene	NA	NA	NA	NA
Total Xylenes	D	ND	NA	ND
<u>Semivolatiles</u>				
51 Acenaphthalene	ND	ND	NA	ND
52 Acenaphthene	ND	ND	NA	ND
53 Acetophenone	ND	ND	NA	ND
54 2-Acetylaminofluorene	ND	ND	NA	ND
55 4-Aminobiphenyl	ND	ND	NA	ND
56 Aniline	ND	ND	NA	ND
57 Anthracene	ND	ND	NA	ND
58 Aramite	NA	NA	NA	NA
59 Benz(a)anthracene	ND	ND	NA	ND
218 Benzal chloride	NA	NA	NA	NA
60 Benzenethiol	ND	ND	NA	ND
61 Benzidine	ND	ND	NA	ND
62 Benzo(a)pyrene	ND	ND	NA	ND

D - This constituent was detected.

NA - This constituent was not analyzed.

ND - This constituent was not detected.

Continued

TABLE 5-2 BDAT List Constituents in Untreated and Treated K102 Waste <sup>a</sup> (Continued)

Parameter	Untreated K102 (mg/kg)	Treated K102 Total (mg/kg)	TCLP (mg/l)	Scrubber Wastewater (mg/l)
<u>Semivolatiles (continued)</u>				
63 Benzo(b)fluoranthene	ND	ND	NA	ND
64 Benzo(ghi)perylene	ND	ND	NA	ND
65 Benzo(k)fluoranthene	ND	ND	NA	ND
66 p-Benzoquinone	ND	ND	NA	ND
67 Bis(2-chloroethoxy)ethane	ND	ND	NA	ND
68 Bis(2-chloroethyl)ether	ND	ND	NA	ND
69 Bis(2-chloroisopropyl)ether	ND	ND	NA	ND
70 Bis(2-ethylhexyl)phthalate	ND	ND	NA	D
71 4-Bromophenyl phenyl ether	ND	ND	NA	ND
72 Butyl benzyl phthlate	ND	ND	NA	ND
73 2-sec-Butyl-4,6-dinitrophenol	ND	ND	NA	ND
74 p-Chloroaniline	ND	ND	NA	ND
75 Chlorobenzilate	NA	NA	NA	NA
76 p-Chloro-m-cresol	ND	ND	NA	ND
77 2-Chloronaphthalene	ND	ND	NA	ND
78 2-Chlorophenol	ND	ND	NA	ND
79 3-Chloropropionitrile	NA	NA	NA	NA
80 Chrysene	ND	ND	NA	ND
81 ortho-Cresol	ND	ND	NA	ND
82 para-Cresol	ND	ND	NA	ND
232 Cyclohexanone	ND	ND	NA	ND
83 Dibenz(a,h)anthracene	ND	ND	NA	ND
84 Dibenzo(a,e)pyrene	NA	NA	NA	NA
85 Dibenzo(a,i)pyrene	NA	NA	NA	NA
86 m-Dichlorobenzene	ND	ND	NA	ND
87 o-Dichlorobenzene	ND	ND	NA	ND
88 p-Dichlorobenzene	ND	ND	NA	ND
89 3,3'-Dichlorobenzidine	ND	ND	NA	ND
90 2,4-Dichlorophenol	ND	ND	NA	ND
91 2,6-Dichlorophenol	ND	ND	NA	ND
92 Diethyl phthalate	ND	ND	NA	ND
93 3,3'-Dimethoxylbenzidine	ND	ND	NA	ND
94 p-Dimethylaminoazobenzene	ND	ND	NA	ND
95 3,3'-Dimethylbenzidine	ND	ND	NA	ND
96 2,4-Dimethylphenol	ND	ND	NA	ND
97 Dimethyl phthalate	ND	ND	NA	ND
98 Di-n-butyl phthalate	ND	ND	NA	ND
99 1,4-Dinitrobenzene	ND	ND	NA	ND
100 4,6-Dinitro-o-cresol	ND	ND	NA	ND
101 2,4-Dinitrophenol	ND	ND	NA	ND

D - This constituent was detected.

NA - This constituent was not analyzed.

ND - This constituent was not detected.

Continued

TABLE 5-2 BDAT List Constituents in Untreated and Treated K102 Waste <sup>a</sup>(Continued)

Parameter	Untreated	Treated K102		Scrubber
	K102 (mg/kg)	Total (mg/kg)	TCLP (mg/l)	Wastewater (mg/l)
<u>Semivolatiles (cont.)</u>				
102 2,4-Dinitrotoluene	ND	ND	NA	ND
103 2,6-Dinitrotoluene	ND	ND	NA	ND
104 Di-n-octyl phthalate	ND	ND	NA	ND
105 Di-n-propylnitrosamine	ND	ND	NA	ND
106 Diphenylamine	ND	ND	NA	ND
219 Diphenylnitrosamine	NA	NA	NA	NA
107 1,2-Diphenylhydrazine	ND	ND	NA	ND
108 Fluoranthene	ND	ND	NA	ND
109 Fluorene	ND	ND	NA	ND
110 Hexachlorobenzene	ND	ND	NA	ND
111 Hexachlorobutadiene	ND	ND	NA	ND
112 Hexachlorocyclopentadiene	ND	ND	NA	ND
113 Hexachloroethane	ND	ND	NA	ND
114 Hexachlorophene	NA	NA	NA	NA
115 Hexachloropropene	ND	ND	NA	ND
116 Indeno(1,2,3-cd)pyrene	ND	ND	NA	ND
117 Isosafrole	ND	ND	NA	ND
118 Methapyrilene	NA	NA	NA	NA
119 3-Methycholanthrene	ND	ND	NA	ND
120 4,4'-Methylenebis(2-chloroaniline)	ND	ND	NA	ND
36 Methyl methanesulfonate	ND	ND	NA	ND
121 Napthalene	ND	ND	NA	ND
122 1,4-Naphthoquinone	NA	NA	NA	NA
123 1-Napthylamine	ND	ND	NA	ND
124 2-Napthylamine	ND	ND	NA	ND
125 p-Nitroaniline	ND	ND	NA	ND
126 Nitrobenzene	ND	ND	NA	ND
*** 2-Nitrophenol	D	ND	NA	ND
127 4-Nitrophenol	ND	ND	NA	ND
128 N-Nitrosodi-n-butylamine	ND	ND	NA	ND
129 N-Nitrosodiethylamine	ND	ND	NA	ND
130 N-Nitrosodimethylamine	ND	ND	NA	ND
131 N-Nitrosomethylethylamine	ND	ND	NA	ND
132 N-Nitrosomorpholine	ND	ND	NA	ND
133 N-Nitrosopiperidine	ND	ND	NA	ND
134 N-Nitrosopyrrolidine	ND	ND	NA	ND
135 5-Nitro-o-toluidine	ND	ND	NA	ND
136 Pentachlorobenzene	ND	ND	NA	ND
137 Pentachloroethane	NA	NA	NA	NA
138 Pentachloronitrobenzene	ND	ND	NA	ND

\*\*\*- Not on BDAT List.

D - This constituent was detected.

NA - This constituent was not analyzed.

ND - This constituent was not detected.

Continued

TABLE 5-2 BDAT List Constituents in Untreated and Treated K102 Waste <sup>a</sup> (Continued)

Parameter	Untreated	Treated K102		Scrubber
	K102 (mg/kg)	Total (mg/kg)	TCLP (mg/l)	Wastewater (mg/l)
<u>Semivolatiles (cont.)</u>				
139 Pentachlorophenol	ND	ND	NA	ND
140 Phenacetin	ND	ND	NA	ND
141 Phenanthrene	ND	ND	NA	ND
142 Phenol	ND	ND	NA	D
220 Phthalic anhydride	ND	ND	NA	ND
143 2-Picoline	ND	ND	NA	ND
144 Pronamide	ND	ND	NA	ND
145 Pyrene	ND	ND	NA	ND
146 Resorcinol	NA	NA	NA	NA
147 Safrole	ND	ND	NA	ND
148 1,2,4,5-Tetrachlorobenzene	ND	ND	NA	ND
149 2,3,4,6-Tetrachlorophenol	ND	ND	NA	ND
150 1,2,4-Trichlorobenzene	ND	ND	NA	ND
151 2,4,5-Trichlorophenol	ND	ND	NA	ND
152 2,4,6-Trichlorophenol	ND	ND	NA	ND
153 Tris(2,3-dibromopropyl)phosphate	ND	ND	NA	ND
<u>Metals</u>				
154 Antimony	D	D	D	D
155 Arsenic	D	D	D	D
156 Barium	D	D	D	D
157 Beryllium	D	ND	ND	D
158 Cadmium	D	D	D	D
159 Chromium	D	D	D	D
221 Chromium (hexavalent)	ND	ND	ND	ND
160 Copper	D	D	D	D
161 Lead	D	D	D	D
162 Mercury	D	D	D	D
163 Nickel	D	D	D	D
164 Selenium	D	D	D	D
165 Silver	ND	ND	ND	D
166 Thallium	D	ND	ND	D
167 Vanadium	D	D	ND	D
168 Zinc	D	D	D	D
<u>Inorganics</u>				
169 Cyanide	D	D	NA	ND
170 Fluoride	D**	D**	NA	D**
171 Sulfide	D	D	NA	D

D - This constituent was detected.

NA - This constituent was not analyzed.

ND - This constituent was not detected.

\*\* - Indicates that only sample set 3 was analyzed for this constituent.

Continued

TABLE 5-2 BDAT List Constituents in Untreated and Treated K102 Waste <sup>a</sup> (Continued)

Parameter		Untreated K102 (mg/kg)	Treated K102 Total (mg/kg)	TCLP (mg/l)	Scrubber Wastewater (mg/l)
<u>Organochlorine Pesticides</u>					
172	Aldrin	NA	NA	NA	NA
173	alpha-BHC	NA	NA	NA	NA
174	beta-BHC	NA	NA	NA	NA
175	delta-BHC	NA	NA	NA	NA
176	gamma-BHC	NA	NA	NA	NA
177	Chlordane	NA	NA	NA	NA
178	DDD	NA	NA	NA	NA
179	DDE	NA	NA	NA	NA
180	DDT	NA	NA	NA	NA
181	Dieldrin	NA	NA	NA	NA
182	Endosulfan I	NA	NA	NA	NA
183	Endosulfan II	NA	NA	NA	NA
184	Endrin	NA	NA	NA	NA
185	Endrin aldehyde	NA	NA	NA	NA
186	Heptachlor	NA	NA	NA	NA
187	Heptachlor epoxide	NA	NA	NA	NA
188	Isodrin	NA	NA	NA	NA
189	Kepone	NA	NA	NA	NA
190	Mehoxychlor	NA	NA	NA	NA
191	Toxaphene	NA	NA	NA	NA
<u>Phenoxyacetic Acid Herbicides</u>					
192	2,4-Dichlorophenoxyacetic acid	NA	NA	NA	NA
193	Silvex	NA	NA	NA	NA
194	2,4,5-T	NA	NA	NA	NA
<u>Organophosphorous Insecticides</u>					
195	Disulfoton	NA	NA	NA	NA
196	Famphur	NA	NA	NA	NA
197	Methyl parathion	NA	NA	NA	NA
198	Paration	NA	NA	NA	NA
199	Phorate	NA	NA	NA	NA
<u>PCBs**</u>					
200	Aroclor 1016	ND	ND	NA	ND
201	Aroclor 1221	ND	ND	NA	ND
202	Aroclor 1232	ND	ND	NA	ND

NA - This constituent was not analyzed.

ND - This constituent was not detected.

Continued



TABLE 5-2 BDAT List Constituents in Untreated and Treated K102 Waste <sup>a</sup> (Continued)

Parameter	Untreated K102 (mg/kg)	Treated K102 Total (mg/kg)	TCLP (mg/l)	Scrubber Wastewater (mg/l)
<u>PCBs**</u> (continued)				
203 Aroclor 1242	ND	ND	NA	ND
204 Aroclor 1248	ND	ND	NA	ND
205 Aroclor 1254	ND	ND	NA	ND
206 Aroclor 1260	ND	ND	NA	ND
<u>Dioxins and Furans**</u>				
207 Hexachlorodibenzo-p-dioxins	ND	ND	NA	ND
208 Hexachlorodibenzofuran	ND	ND	NA	ND
209 Pentachlorodibenzo-p-dioxins	ND	ND	NA	ND
210 Pentachlorodibenzofuran	ND	ND	NA	ND
211 Tetrachlorodibenzo-p-dioxins	ND	ND	NA	ND
212 Tetrachlorodibenzofuran	ND	ND	NA	ND
213 2,3,7,8-Tetrachlorodibenzo-p-dioxin	ND	ND	NA	ND

a - Obtained from Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K102.  
Tables 5-2 through 5-9.

NA - This constituent was not analyzed.

ND - This constituent was not detected.

copper, lead, mercury, nickel, selenium, vanadium, zinc, fluoride, and sulfide.

The following constituents were detected in the scrubber waters generated from incineration: bis(2-ethylhexyl) phthalate, phenol, antimony, barium, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, vanadium, and zinc.

Some constituents were detected in the ash and scrubber water which were not detected in the untreated waste. Organic constituents detected in the scrubber water but not detected in the untreated waste had detection limits considerably lower than in the untreated waste. Metal constituents detected in the treated waste but not detected or lower in concentrations than in the untreated waste may be present due to lower detection limits or operating conditions of the kiln. This is the case for both K101 and K102.

The untreated and treated waste samples were not analyzed for other classes of BDAT organics (organochlorine pesticides, phenoxyacetic acid herbicides, and organophosphorus pesticides) because there is no in-process source of these constituents and because of the extreme unlikelihood of finding these constituents at treatable levels in the waste.

## 5.2 Constituents Detected in the Untreated Waste But Not Considered for Regulation

Some BDAT metal constituents, beryllium, mercury, selenium, silver, thallium, and vanadium, which were detected in the untreated waste, were not present at treatable levels in the kiln ash for K101 and K102 waste codes. Therefore, these metals were not selected as regulated constituents for kiln ash nonwastewaters of K101 and K102.

Metal constituents present in K101 and K102 scrubber water that were not selected for regulation in the wastewaters are as follows: barium, beryllium, chromium, copper, nickel, selenium, silver, thallium, vanadium, and zinc. These metals were not selected because they were not present at treatable levels in the scrubber water.

The non-metallic inorganic constituents were generally present in untreatable concentrations in the untreated waste codes K101 and K102. Also, by comparing the concentration of cyanide and fluoride in the untreated and treated waste for both waste codes, the Agency concluded that these two constituents were not substantially treated. The Agency recognizes that the sulfide concentration was diminished in the treated waste, but considers this an incidental treatment since the treatment technology tested is not demonstrated for the treatment of sulfides. As a result, the BDAT list inorganic constituents

(other than metals) in K101 and K102 were eliminated as a class of BDAT list constituents to be regulated in waste codes K101 and K102.

The remaining two classes of constituents, namely, volatiles and semivolatiles, were generally present at treatable concentration levels in the untreated waste. Volatiles and semivolatiles were judged to be substantially treated by incineration. Only bis(2-ethylhexyl)phthalate was not considered for regulation since it is believed to be a contaminant due to sample containerization.

Tables 5-3 and 5-4 list the constituents considered for regulation by class and waste form. The selection of constituents is presented below.

### 5.3 Constituents Selected for Regulation

The Agency evaluated the analytical data for each constituent to determine if the constituent should be selected for regulation. In general, the Agency was guided by the criteria for selecting regulated constituents as described in Section 1 of this background document. Table 5-5 lists the constituents selected for regulation by class. The rationale for selecting the regulated constituents is presented below.

TABLE 5-3 CONSTITUENTS CONSIDERED FOR REGULATION IN K101

CONSTITUENT	NONWASTEWATERS	WASTEWATERS
Volatile Organics		
Acetone	X	X
Toluene	X	X
Semi-Volatile Organics		
2-Nitroaniline	X	X
Metals		
Antimony	X	X
Arsenic	X	X
Barium	X	
Cadmium	X	X
Chromium	X	
Copper	X	
Lead	X	X
Mercury		X
Nickel	X	
Zinc	X	

TABLE 5-4 CONSTITUENTS CONSIDERED FOR REGULATION IN K102

CONSTITUENT	NONWASTEWATERS	WASTEWATERS
Volatile Organics		
Toluene	X	X
Total Xylenes	X	X
Semi-Volatile Organics		
2-Nitrophenol	X	X
Phenol	X	X
Metals		
Antimony	X	X
Arsenic	X	X
Barium	X	
Cadmium	X	X
Chromium	X	
Copper	X	
Lead	X	X
Mercury		X
Nickel	X	
Zinc	X	

TABLE 5-5 CONSTITUENTS SELECTED FOR REGULATION IN K101/K102

CONSTITUENT	NONWASTEWATERS	WASTEWATERS
Semi-Volatile Organics		
2-Nitroaniline *	X	X
2-Nitrophenol **	X	X
Metals		
Arsenic	X	X
Antimony	X	X
Barium	X	
Cadmium	X	X
Chromium	X	
Copper	X	
Lead	X	X
Mercury		X
Nickel	X	
Zinc	X	

\* Regulated only in K101.

\*\* Regulated only in K102.

### 5.3.1 Nonwastewaters

#### Volatile and Semivolatile Organics

The non-BDAT constituent 2-nitroaniline was present in significant concentrations in untreated K101. It was substantially treated by incineration. Therefore, 2-nitroaniline was selected as a regulated constituent for K101 organic nonwastewaters. It was also selected because it will indicate whether or not the treatment system has substantially reduced organic constituent concentrations in K101. The boiling point of 2-nitroaniline is 284°C, higher than the other organic constituents present in untreated K101. Therefore, if 2-nitroaniline is effectively treated by incineration, then other organics present in K101 are also effectively treated.

Acetone and toluene were present at moderate levels in untreated K101, but were not detected in the treated waste. The boiling points of acetone and toluene are 56.2°C and 110.6°C, respectively, which are considerably lower than that of 2-nitroaniline. The Agency also considers the detection limits for aniline in untreated K101 waste unusually high and believes aniline was present at moderate levels. The boiling point of aniline is 184-186°C. Therefore, if 2-nitroaniline is effectively treated, then acetone, toluene and aniline will also be treated. As a result, acetone, toluene and aniline will not



be proposed for regulation at this time. However, treatment standards have been developed in Section 6. .

The constituent that is selected for regulation in K102 as the indicator for the destruction of organics present in the waste is 2-nitrophenol. The non-BDAT constituent 2-nitrophenol was detected in treatable concentrations in untreated K102. It is was not detected in the treated waste. The boiling point of 2-nitrophenol is 216°C which is higher than the boiling points of other organic constituents present in untreated K102. Therefore, the effective treatment of 2-nitrophenol will indicate that organics present in untreated K102 have also been effectively treated.

Toluene and xylenes were detected at moderate levels in untreated K102. The boiling points of ortho, meta, and para-xylenes are 144.4°C, 139.1°C, and 138.3°C, respectively. Toluene and xylenes will not be selected for regulation because if 2-nitrophenol is effectively treated, then toluene and xylenes will also be treated.

### Metals

Incineration is not an applicable or demonstrated treatment of BDAT list metals. The incinerator ash and scrubber water generated by the incineration process contain treatable

concentration levels for several metal constituents. The EPA did not collect data for the stabilization of the BDAT list metals for K101 and K102. However, nonwastewaters with similar constituents and characteristics have been effectively treated by metals stabilization. Therefore, metals stabilization is believed to effectively treat the metal constituents in K101 and K102 nonwastewaters.

Selection of metal constituents to be regulated in K101 and K102 is dependent upon the concentration of the metals in the incinerator ash. For the purposes of transferring data, the incinerator ash is considered the untreated waste and the performance data which is transferred is considered the treated waste. The K101 and K102 metals concentrations in the ash must be compared to data for the waste codes that are being considered for transferring data. Only constituents present and at treatable levels will be considered for regulation. After a comparison with several nonwastewaters, F006 metals stabilization data was transferred to K101 and K102.

Arsenic, antimony and barium will not be regulated in the K101 and K102 nonwastewaters at this time. The Agency is investigating other treatment techniques for these three metals. For K101 and K102 kiln ash nonwastewaters, the other metals present in the kiln ash at treatable levels for metals stabilization are cadmium, chromium, copper, lead, nickel, and

zinc. The Agency believes that metals stabilization of the kiln ash will effectively reduce the leachability of the metal constituents present in the nonwastewaters.

#### 5.3.2 Wastewaters

##### Volatile and Semivolatile Organics

The two organic indicators, 2-nitroaniline and 2-nitrophenol, selected for K101 and K102 nonwastewaters respectively, were also selected for the wastewater forms of K101 and K102. The rationale for their selection is the same as the one discussed for K101 and K102 nonwastewaters. If 2-nitroaniline and 2-nitrophenol are effectively treated by incineration, then other organics present in the waste will also be reduced to acceptable concentration levels.

## Metals

The BDAT list metal constituents antimony, arsenic, cadmium, lead, and mercury were present at treatable levels in the scrubber water for treatment by chemical precipitation. The Agency believes that chemical precipitation of the scrubber water for K101 and K102 will effectively treat the metals present at treatable concentrations. As a result, the five metals listed above were selected as regulated constituents for waste codes K101 and K102 wastewaters. At this time the treatment standard for antimony will be deferred until a suitable waste code has been selected for the transference of data.

## 6. CALCULATION OF TREATMENT STANDARDS

In this section, the actual treatment standards for waste codes K101 and K102 are presented. These standards were calculated based on the performance of the demonstrated treatment system which was determined by the Agency to be the best for treating both waste codes. In Section 4, BDAT for the listed waste codes K101 and K102 was determined to be rotary kiln incineration, followed by stabilization of the resulting ash, and chemical precipitation of the scrubber water followed by stabilization of the resulting precipitate. The previous section identified the constituents proposed for regulation for the nonwastewater and wastewater forms of K101 and K102 wastes.

As discussed in Section 1, the Agency calculated the BDAT treatment standards for waste codes K101 and K102 by following a four-step procedure: (1) editing the data; (2) correcting the remaining data for analytical interference; (3) calculating adjustment factors (variability factors) to account for process variability; and (4) calculating the actual treatment standards using variability factors and average treatment values. The four steps in this procedure are discussed in detail in Sections 6.1 through 6.4.

## 6.1 Editing the Data

### 6.1.1 Nonwastewaters

Four sets of treatment data for waste code K101 and six sets of treatment data for waste code K102 were collected by the Agency from a treatment system consisting of rotary kiln incineration. Three samples of the treated K101 waste were collected at the end of the performance test and were analyzed. Four samples of treated K102 waste were collected during the performance test and were analyzed. The Agency evaluated the seven data sets to determine if the treatment system was well operated at the time of the sampling visit. None of the data sets were eliminated on the basis of this evaluation.

The performance data used for evaluating metals stabilization was transferred from F006.

### 6.1.2 Wastewaters

Five data sets were collected by the Agency from a treatment system consisting of chemical precipitation for D004. The performance data were transferred to the wastewaters in K101 and K102 based upon waste characteristics affecting performance. The

Agency evaluated the five data sets to determine if the treatment system was well operated at the time of the engineering visit. None of the data sets were eliminated on the basis of this evaluation.

## 6.2 Correcting the Remaining Data

All data values were corrected in order to take into account analytical interferences associated with the chemical make-up of the treated sample. This was accomplished by calculating an accuracy factor from the percent recoveries for the selected regulated constituents in K101 and K102. The actual recovery values and accuracy factors for the selected constituents are presented in Appendix B. The corrected concentration values for K101 and K102 nonwastewaters are shown in Tables 6-1 and 6-2. The corrected concentration values for K101 and K102 wastewaters are shown in Table 6-3. The corrected concentration values were obtained by multiplying the accuracy factors by the concentration values in the treated waste. Arithmetic average values, representing the treated waste concentration, were calculated for all constituents in K101 and K102 from the corrected concentrations.

### 6.3 Calculating Variability Factors

It is expected that in normal operation of a well-designed and well-operated treatment system there will be some variability in performance. Based on the test data, a measure of this variability is expressed by the variability factor. The methodology for calculating variability factors is explained in Appendix A of this report. Tables 6-1 through 6-3 present the results of calculations for the selected constituents in nonwastewaters and wastewaters. Appendix D of this report shows how the actual values in Tables 6-1 through 6-3 were calculated.

In instances where a selected constituent was not detected in the treated waste, the treated value for that constituent was assumed to be the detection limits. For example, both 2-nitroaniline in K101 and 2-nitrophenol in K102 were not detected in the incinerator ash or the scrubber water, and concentration values for the incinerator ash and scrubber water were set at their detection limits. This resulted in no apparent variation among the treated values and a calculated variability factor of 1.0. A variability factor of 1.0 represents test data from a process measured without variation and analytical interferences. Instead of using the calculated value of 1.0, the variability factors for 2-nitroaniline and 2-nitrophenol were fixed at 2.8 as justified in Appendix A of this document.



Table 6-1 Regulated Constituents and Calculated Treatment Standards for Organics in K101 and K102 Nonwastewaters <sup>a</sup>

BDAT Constituent	Accuracy-Corrected Concentration (mg/kg)				Average Treated Waste Concentration (mg/kg)	Variability Factor (VF)	Treatment Standard (mg/kg) (Average x VF)
	Sample Set #1	Sample Set #2	Sample Set #3	Sample Set #4			
<u>K101 REGULATED CONSTITUENTS</u>							
Volatile							
*Acetone <sup>1</sup>	0.010	0.010	0.010	---	0.010	2.80	0.028
*Toluene	0.005	0.005	0.005	---	0.005	2.80	0.014
Semivolatile							
*Aniline <sup>2</sup>	1.050	1.050	1.050	---	1.050	2.80	2.940
*** 2-Nitroaniline <sup>2</sup>	5.000	5.000	5.000	---	5.000	2.80	14.000
<u>K102 REGULATED CONSTITUENTS</u>							
Volatile							
*Toluene	1.500	1.500	1.500	1.500	1.500	2.80	4.200
*Total Xylenes <sup>1</sup>	1.500	1.500	1.500	1.500	1.500	2.80	4.200
Semivolatile							
*** 2-Nitrophenol <sup>3</sup>	4.760	4.760	4.760	4.760	4.760	2.80	13.328
*Phenol	1.640	1.640	1.640	1.640	1.640	2.80	4.592

a - Accuracy Correction Factors and Variability Factors were determined as discussed in Appendix A.

\* - Not proposed for regulation.

\*\*\* - Not on BDAT List.

1 - The average percent recovery for volatiles was used in the calculation of the this standard.

2 - The average percent recovery for semivolatiles was used in the calculation of the this standard.

3 - Percent recovery of 4-Nitrophenol was used in the calculation of the standard for 2-Nitrophenol.

Table 6-2 Regulated Constituents and Calculated Treatment Standards for Inorganics in K101 and K102 Nonwastewaters

Accuracy Corrected Constituents Concentrations in Treated Leachate (mg/l)									
Antimony	Arsenic	Barium	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	
			-	-	-	-	0.04	0.03	
			0.01	0.46	0.27	0.39	0.03	0.01	
			0.06	0.09	0.16	0.34	0.26	0.05	
			0.01	-	0.29	0.23	0.02	0.01	
			0.01	0.35	0.31	0.37	0.03	0.04	
			0.01	0.44	0.45	0.39	0.04	0.03	
			0.01	1.4	0.35	0.41	0.11	0.02	
			0.01	-	0.50	0.40	0.04	0.02	
			-	-	-	0.29	0.02	0.01	
Average concentration			0.017	0.55	0.33	0.35	0.066	0.024	
Variability factor			3.9	6.9	2.2	1.5	4.7	3.6	
Treatment standard	**	**	**	0.066	3.8	0.71	0.53	0.31	0.086

\*\* - Deferred for proposed regulation until later date.

Table 6-3 Regulated Constituents and Calculated Treatment Standards for K101 and K102 Wastewaters

BDAT Constituent	Accuracy-Corrected Concentration (mg/L)						Average Treated Waste Concentration (mg/L)	Variability Factor (VF)	Treatment Standard (mg/L) (Average x VF)
	Sample Set #1	Sample Set #2	Sample Set #3	Sample Set #4	Sample Set #5	Sample Set #6			
<u>Semivolatiles</u>									
***2-Nitroaniline * 1	0.095	0.095	0.095	0.095	---	---	0.095	2.80	0.266
***2-Nitrophenol * 2	0.010	0.010	0.010	0.010	0.010	0.010	0.010	2.80	0.028
<u>Metals</u> 3									
Antimony									**
Arsenic	0.291	1.400	0.359	0.293	0.308	---	0.530	3.842	2.036
Cadmium	0.085	0.085	0.085	0.085	0.085	---	0.085	2.80	0.238
Lead	0.006	0.035	0.030	0.012	0.030	---	0.023	4.783	0.110
Mercury	0.001	0.004	0.009	0.004	0.006	---	0.005	2.80	0.027

\* - 2-Nitroaniline is proposed for regulation in K101 only. 2-Nitrophenol is proposed for regulation in K102 only.

\*\* - Deferred for proposed regulation until later date.

\*\*\* - Not on BDAT List.

1 - The average percent recovery of all semivolatiles was used in the calculation of the standard for 2-Nitroaniline.

2 - Percent recovery of 4-Nitrophenol was used in the calculation of the standard for 2-Nitrophenol.

3 - Performance data for metals were transferred from D004 (see Section 5 of the Onsite Engineering Report for D004).

#### 6.4 Calculating the Treatment Standards

The treatment standards for the selected constituents were calculated by multiplying the variability factors by the average concentration values for the treated waste. The treatment standards for K101/K102 nonwastewaters are presented in Tables 6-1 and 6-2. The treatment standards for K101/K102 wastewaters are presented in Table 6-3.

##### 6.4.1 Nonwastewaters

No performance data were available for the treatment of metals in K101 and K102 nonwastewaters. The Agency, therefore, decided to transfer performance data from the treatment of wastes which were determined to be similar to K101 and K102 nonwastewaters based on waste characteristics affecting performance. The nonwastewater performance data for K101 and K102 were transferred from treatment data for EPA hazardous waste code F006. Table 6-2 provides treatment standards for proposed regulated constituents in F006. The concentrations of metals in the untreated F006 waste were compared to metal concentrations in K101/K102 nonwastewaters. Data from F006 were transferred on a metal-specific basis, provided the concentration of metal in the untreated F006 was greater than in the untreated K101 and K102. In this manner performance data were transferred for six out of nine proposed metals in K101 and K102 nonwastewaters. They are

as follows: cadmium, chromium, copper, lead, nickel, and zinc. Performance data for the three deferred metals, antimony, arsenic, and barium were not transferred from F006 because either the constituents existed at much higher concentrations in the untreated K101 and K102 nonwastewaters than in untreated F006 nonwastewater or because F006 performance data did not show significant treatment. The Agency is investigating other treatment techniques for these three metals, and is reserving the antimony, arsenic and barium standards for a future date.

The BDAT nonwastewater treatment standards for waste code K101 and K102 are as follows:

<u>Constituent</u>	<u>Total Composition</u> (mg/kg)	<u>TCLP</u> (mg/l)
2-nitroaniline*	14.000	N/A
2-nitrophenol**	13.328	N/A
Antimony	N/A	deferred
Arsenic	N/A	deferred
Barium	N/A	deferred
Cadmium	N/A	0.066
Chromium	N/A	3.8
Copper	N/A	0.71
Lead	N/A	0.53
Nickel	N/A	0.31
Zinc	N/A	0.086

N/A = Not Applicable

\* Regulated in K101 only

\*\* Regulated in K102 only

The Agency has also calculated treatment standards for BDAT list organics which are present in untreated K101 in lower concentrations than 2-nitroaniline, and in untreated K102 which are present at lower concentrations than 2-nitrophenol (see Table 6-1). These calculated standards are as follows:

Organic Constituent	TREATMENT STANDARD	
	K101 (mg/kg)	K102 (mg/kg)
Acetone	0.028	NR
Toluene	0.014	4.200
Aniline	2.940	NR
Total Xylenes	NR	4.200
Phenol	NR	4.592

NR = Not regulated since it is not present at treatable levels.

If the Agency considers regulating BDAT list organics which are present in untreated K101 and K102 at lower concentration levels than 2-nitroaniline and 2-nitrophenol, then acetone, toluene, and aniline in K101, and toluene, total xylenes, and phenol in K102 would be the constituents under consideration.

#### 6.4.2 Wastewaters

No performance data were available for the treatment of K101 and K102 wastewaters. The Agency, therefore, decided to transfer performance data from the treatment of wastes which were determined to be similar to K101 and K102 wastewaters based on

waste characteristics affecting performance. The wastewater performance data for waste codes K101 and K102 were transferred from treatment data for D004. Table 6-3 provides treatment standards for proposed regulated metals in D004. The concentrations of metals in the untreated characteristic waste D004 and K101/K102 wastewaters were compared, and performance data from D004 were transferred to K101 and K102 on a metal-specific basis, provided the concentration of the metal in the untreated characteristic waste D004, was greater than in untreated K101 and K102. In this manner performance data were transferred for four of the five proposed metals in K101 and K102 wastewaters, namely arsenic, cadmium, lead, and mercury. Performance data for the other regulated metal in K101 and K102 wastewaters, namely antimony, was not transferred from D004 because antimony existed at a much higher concentration in the untreated K101 and K102 wastewaters than in untreated D004 wastewaters.<sup>1</sup> Therefore, the Agency reserves the antimony standard for a future date.

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1. Onsite Engineering Report for Salsbury Laboratories for D004. Section 5.

The BDAT wastewater treatment standards for K101 and K102 are as follows:

Constituent	Total Composition (mg/l)
2-Nitroaniline	0.266
2-Nitrophenol	0.028
Antimony	deferred
Arsenic	2.036
Cadmium	0.238
Lead	0.110
Mercury	0.027



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## APPENDIX A - STATISTICAL ANALYSIS

### A.1 F Value Determination for ANOVA Test

As noted earlier in Section 1.0, EPA is using the statistical method known as analysis of variance in the determination of the level of performance that represents "best" treatment where more than one technology is demonstrated. This method provides a measure of the differences between data sets. If the differences are not statistically significant, the data sets are said to be homogeneous.

If the Agency found that the levels of performance for one or more technologies are not statistically different (i.e., the data sets are homogeneous), EPA would average the long term performance values achieved by each technology and then multiply this value by the largest variability factor associated with any of the acceptable technologies. If EPA found that one technology performs significantly better (i.e., the data sets are not homogeneous), BDAT would be the level of performance achieved by the best technology multiplied by its variability factor.

To determine whether any or all of the treatment performance data sets are homogeneous using the analysis of variance method, it is necessary to compare a calculated "F value" to what is known as a "critical value." (See Table A-1.) These critical

values are available in most statistics texts (see, for example, Statistical Concepts and Methods by Bhattacharyya and Johnson, 1977, John Wiley Publications, New York).

Where the F value is less than the critical value, all treatment data sets are homogeneous. If the F value exceeds the critical value, it is necessary to perform a "pair wise F" test to determine if any of the sets are homogeneous. The "pair wise F" test must be done for all of the various combinations of data sets using the same method and equation as the general F test.

The F value is calculated as follows:

- (i) All data are natural logtransformed.
- (ii) The sum of the data points for each data set is computed ( $T_i$ ).
- (iii) The statistical parameter known as the sum of the squares between data sets (SSB) is computed:

$$SSB = \left[ \sum_{i=1}^k \left( \frac{T_i^2}{n_i} \right) \right] - \left[ \frac{\left[ \sum_{i=1}^k T_i \right]^2}{N} \right]$$

where:

k = number of treatment technologies  
 $n_i$  = number of data points for technology i  
 $N$  = number of data points for all technologies  
 $T_i$  = sum of natural logtransformed data points for each technology.

- (iv) The sum of the squares within data sets (SSW) is computed:

$$SSW = \left[ \sum_{i=1}^k \sum_{j=1}^{n_i} x_{i,j}^2 \right] - \sum_{i=1}^k \left( \frac{T_i^2}{n_i} \right)$$

where:

$x_{i,j}$  = the natural logtransformed observations (j) for treatment technology (i).

- (v) The degrees of freedom corresponding to SSB and SSW are calculated. For SSB, the degree of freedom is given by  $k-1$ . For SSW, the degree of freedom is given by  $N-k$ .

- (vi) Using the above parameters, the F value is calculated as follows:

$$F = \frac{MSB}{MSW}$$

where:

$MSB = SSB/(k-1)$  and

$MSW = SSW/(N-k)$ .

A computational table summarizing the above parameters is shown below.

Computational Table for the F Value

Source	Degrees of freedom	Sum of squares	Mean square	F
Between	K-1	SSB	$MSB = SSB/k-1$	MSB/MSW
Within	N-k	SSW	$MSW = SSW/N-k$	

Below are three examples of the ANOVA calculation. The first two represent treatment by different technologies that achieve statistically similar treatment; the last example represents a case where one technology achieves significantly better treatment than the other technology.

Table A-1  
F Distribution at the 95 Percent Confidence Level

Denominator degrees of freedom	$F_{0.95}$								
	Numerator degrees of freedom								
	1	2	3	4	5	6	7	8	9
1	161.4	199.5	215.7	224.6	230.2	234.0	236.8	238.9	240.5
2	18.51	19.00	19.16	19.25	19.30	19.33	19.35	19.37	19.38
3	10.13	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81
4	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00
5	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77
6	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10
7	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68
8	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39
9	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18
10	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02
11	4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90
12	4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80
13	4.67	3.81	3.41	3.18	3.03	2.92	2.83	2.77	2.71
14	4.60	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65
15	4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59
16	4.49	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54
17	4.45	3.59	3.20	2.96	2.81	2.70	2.61	2.55	2.49
18	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46
19	4.38	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.42
20	4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39
21	4.32	3.47	3.07	2.84	2.68	2.57	2.49	2.42	2.37
22	4.30	3.44	3.05	2.82	2.66	2.55	2.46	2.40	2.34
23	4.28	3.42	3.03	2.80	2.64	2.53	2.44	2.37	2.32
24	4.26	3.40	3.01	2.78	2.62	2.51	2.42	2.36	2.30
25	4.24	3.39	2.99	2.76	2.60	2.49	2.40	2.34	2.28
26	4.23	3.37	2.98	2.74	2.59	2.47	2.39	2.32	2.27
27	4.21	3.35	2.96	2.73	2.57	2.46	2.37	2.31	2.25
28	4.20	3.34	2.95	2.71	2.56	2.45	2.36	2.29	2.24
29	4.18	3.33	2.93	2.70	2.55	2.43	2.35	2.28	2.22
30	4.17	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21
40	4.08	3.23	2.84	2.61	2.45	2.34	2.25	2.18	2.12
60	4.00	3.15	2.76	2.53	2.37	2.25	2.17	2.10	2.04
120	3.92	3.07	2.68	2.45	2.29	2.17	2.09	2.02	1.96
∞	3.84	3.00	2.60	2.37	2.21	2.10	2.01	1.94	1.88



Example 1  
Methylene Chloride

Steam stripping				Biological treatment			
Influent (mg/l)	Effluent (mg/l)	ln(effluent)	[ln(effluent)] <sup>2</sup>	Influent (mg/l)	Effluent (mg/l)	ln(effluent)	[ln(effluent)] <sup>2</sup>
1550.00	10.00	2.30	5.29	1960.00	10.00	2.30	5.29
1290.00	10.00	2.30	5.29	2568.00	10.00	2.30	5.29
1640.00	10.00	2.30	5.29	1817.00	10.00	2.30	5.29
5100.00	12.00	2.48	6.15	1640.00	26.00	3.26	10.63
1450.00	10.00	2.30	5.29	3907.00	10.00	2.30	5.29
4600.00	10.00	2.30	5.29				
1760.00	10.00	2.30	5.29				
2400.00	10.00	2.30	5.29				
4800.00	10.00	2.30	5.29				
12100.00	10.00	2.30	5.29				
<hr/>							
Sum:	-	23.18	53.76	-	-	12.46	31.79
<hr/>							
Sample Size:							
10	10	10	-	5	5	5	-
<hr/>							
Mean:							
3669	10.2	2.32	-	2378	13.2	2.49	-
<hr/>							
Standard Deviation:							
3328.67	.63	.06	-	923.04	7.15	.43	-
<hr/>							
Variability Factor:							
	1.15	-	-	-	2.48	-	-

ANOVA Calculations:

$$SSB = \left[ \sum_{i=1}^k \left( \frac{T_i^2}{n_i} \right) \right] - \left( \frac{\left[ \sum_{i=1}^k T_i \right]^2}{N} \right)$$

$$SSW = \left[ \sum_{i=1}^k \sum_{j=1}^{n_i} x_{i,j}^2 \right] - \sum_{i=1}^k \left( \frac{T_i^2}{n_i} \right)$$

$$MSB = SSB/(k-1)$$

$$MSW = SSW/(N-k)$$

Example 1 (continued)

$$F = MSB/MSW$$

where:

$k$  = number of treatment technologies

$n_i$  = number of data points for technology  $i$

$N$  = number of natural log transformed data points for all technologies

$T_i$  = sum of log transformed data points for each technology

$X_{ij}$  = the nat. log transformed observations ( $j$ ) for treatment technology ( $i$ )

$$n_1 = 10, n_2 = 5, N = 15, k = 2, T_1 = 23.18, T_2 = 12.46, T = 35.64, T^2 = 1270.21$$

$$T_1^2 = 537.31 \quad T_2^2 = 155.25$$

$$SSB = \left( \frac{537.31}{10} + \frac{155.25}{5} \right) - \frac{1270.21}{15} = 0.10$$

$$SSW = (53.76 + 31.79) - \left( \frac{537.31}{10} + \frac{155.25}{5} \right) = 0.77$$

$$MSB = 0.10/1 = 0.10$$

$$MSW = 0.77/13 = 0.06$$

$$F = \frac{0.10}{0.06} = 1.67$$

ANOVA Table

Source	Degrees of freedom	SS	MS	F
Between(B)	1	0.10	0.10	1.67
Within(W)	13	0.77	0.06	

The critical value of the F test at the 0.05 significance level is 4.67. Since the F value is less than the critical value, the means are not significantly different (i.e., they are homogeneous).

Note: All calculations were rounded to two decimal places. Results may differ depending upon the number of decimal places used in each step of the calculations.

Example 2  
Trichloroethylene

Steam stripping				Biological treatment			
Influent (mg/l)	Effluent (mg/l)	ln(effluent)	[ln(effluent)] <sup>2</sup>	Influent (mg/l)	Effluent (mg/l)	ln(effluent)	[ln(effluent)] <sup>2</sup>
1650.00	10.00	2.30	5.29	200.00	10.00	2.30	5.29
5200.00	10.00	2.30	5.29	224.00	10.00	2.30	5.29
5000.00	10.00	2.30	5.29	134.00	10.00	2.30	5.29
1720.00	10.00	2.30	5.29	150.00	10.00	2.30	5.29
1560.00	10.00	2.30	5.29	484.00	16.25	2.79	7.78
10300.00	10.00	2.30	5.29	163.00	10.00	2.30	5.29
210.00	10.00	2.30	5.29	182.00	10.00	2.30	5.29
1600.00	27.00	3.30	10.89				
204.00	85.00	4.44	19.71				
160.00	10.00	2.30	5.29				
Sum:							
-	-	26.14	72.92	-	-	16.59	39.52
Sample Size:							
10	10	10	-	7	7	7	-
Mean:							
2760	19.2	2.61	-	220	10.89	2.37	-
Standard Deviation:							
3209.6	23.7	.71	-	120.5	2.36	.19	-
Variability Factor:							
-	3.70	-	-	-	1.53	-	-

ANOVA Calculations:

$$SSB = \left[ \sum_{i=1}^k \left( \frac{T_i^2}{n_i} \right) \right] - \left( \frac{\left[ \sum_{i=1}^k T_i \right]^2}{N} \right)$$

$$SSW = \left[ \sum_{i=1}^k \sum_{j=1}^{n_i} x_{i,j}^2 \right] - \sum_{i=1}^k \left( \frac{T_i^2}{n_i} \right)$$

$$MSB = SSB/(k-1)$$

$$MSW = SSW/(N-k)$$

Example 2 (continued)

$$F = MSB/MSW$$

where:

$k$  = number of treatment technologies

$n_i$  = number of data points for technology  $i$

$N$  = number of data points for all technologies

$T_i$  = sum of natural log transformed data points for each technology

$X_{ij}$  = the natural log transformed observations ( $j$ ) for treatment technology ( $i$ )

$$N_1 = 10, N_2 = 7, N = 17, k = 2, T_1 = 26.14, T_2 = 16.59, T = 42.73, T^2 = 1825.85, T_1^2 = 683.30,$$

$$T_2^2 = 275.23$$

$$SSB = \left( \frac{683.30}{10} + \frac{275.23}{7} \right) - \frac{1825.85}{17} = 0.25$$

$$SSW = (72.92 + 39.52) - \left( \frac{683.30}{10} + \frac{275.23}{7} \right) = 4.79$$

$$MSB = 0.25/1 = 0.25$$

$$MSW = 4.79/15 = 0.32$$

$$F = \frac{0.25}{0.32} = 0.78$$

ANOVA Table

Source	Degrees of freedom	SS	MS	F
Between(B)	1	0.25	0.25	0.78
Within(W)	15	4.79	0.32	

The critical value of the F test at the 0.05 significance level is 4.54. Since the F value is less than the critical value, the means are not significantly different (i.e., they are homogeneous).

Note: All calculations were rounded to two decimal places. Results may differ depending upon the number of decimal places used in each step of the calculations.

Example 3  
Chlorobenzene

Activated sludge followed by carbon adsorption				Biological treatment			
Influent (mg/l)	Effluent (mg/l)	ln(effluent)	[ln(effluent)] <sup>2</sup>	Influent (mg/l)	Effluent (mg/l)	ln(effluent)	ln[(effluent)] <sup>2</sup>
7200.00	80.00	4.38	19.18	9206.00	1083.00	6.99	48.86
6500.00	70.00	4.25	18.06	16646.00	709.50	6.56	43.03
6075.00	35.00	3.56	12.67	49775.00	460.00	6.13	37.58
3040.00	10.00	2.30	5.29	14731.00	142.00	4.96	24.60
				3159.00	603.00	6.40	40.96
				6756.00	153.00	5.03	25.30
				3040.00	17.00	2.83	8.01
Sum:							
-	-	14.49	55.20	-	-	38.90	228.34
Sample Size:							
4	4	4	-	7	7	7	-
Mean:							
5703	49	3.62	-	14759	452.5	5.56	-
Standard Deviation:							
1835.4	32.24	.95		16311.86	379.04	1.42	-
Variability Factor:							
-	7.00	-	-	-	15.79	-	-

ANOVA Calculations:

$$SSB = \left[ \sum_{i=1}^k \left( \frac{T_i^2}{n_i} \right) \right] - \left( \left[ \frac{\sum_{i=1}^k T_i}{N} \right]^2 \right)$$

$$SSW = \left[ \sum_{i=1}^k \sum_{j=1}^{n_i} x_{i,j}^2 \right] - \sum_{i=1}^k \left( \frac{T_i^2}{n_i} \right)$$

$$MSB = SSB/(k-1)$$

$$MSW = SSW/(N-k)$$

$$F = MSB/MSW$$

Example 3 (continued)

where,

$k$  = number of treatment technologies

$n_i$  = number of data points for technology  $i$

$N$  = number of data points for all technologies

$T_i$  = sum of natural log transformed data points for each technology

$X_{ij}$  = the natural log transformed observations ( $j$ ) for treatment technology ( $i$ )

$$N_1 = 4, N_2 = 7, N = 11, k = 2, T_1 = 14.49, T_2 = 38.90, T = 53.39, T^2 = 2850.49, T_1^2 = 209.96$$

$$T_2^2 = 1513.21$$

$$SSB = \left( \frac{209.96}{4} + \frac{1513.21}{7} \right) - \frac{2850.49}{11} = 9.52$$

$$SSW = (55.20 + 228.34) - \left( \frac{209.96}{4} + \frac{1513.21}{7} \right) = 14.88$$

$$MSB = 9.52/1 = 9.52$$

$$MSW = 14.88/9 = 1.65$$

$$F = 9.52/1.65 = 5.77$$

ANOVA Table

Source	Degrees of freedom	SS	MS	F
Between(B)	1	9.53	9.53	5.77
Within(W)	9	14.89	1.65	

The critical value of the F test at the 0.05 significance level is 5.12. Since the F value is larger than the critical value, the means are significantly different (i.e., they are heterogeneous).

Note: All calculations were rounded to two decimal places. Results may differ depending upon the number of decimal places used in each step of the calculations.

## A.2. Variability Factor

$$VF = \frac{C_{99}}{\text{Mean}}$$

where:

VF = estimate of daily maximum variability factor determined from a sample population of daily data.  
C<sub>99</sub> = Estimate of performance values for which 99 percent of the daily observations will be below. C<sub>99</sub> is calculated using the following equation:  
C<sub>99</sub> = Exp(y + 2.33 Sy) where y and Sy are the mean and standard deviation, respectively, of the logtransformed data.  
Mean = average of the individual performance values.

EPA is establishing this figure as an instantaneous maximum because the Agency believes that on a day-to-day basis the waste should meet the applicable treatment standards. In addition, establishing this requirement makes it easier to check compliance on a single day. The 99th percentile is appropriate because it accounts for almost all process variability.

In several cases, all the results from analysis of the residuals from BDAT treatment are found at concentrations less than the detection limit. In such cases, all the actual concentration values are considered unknown and hence, cannot be used to estimate the variability factor of the analytical results. Below is a description of EPA's approach for calculating the variability factor for such cases with all concentrations below the detection limit.

It has been postulated as a general rule that a lognormal distribution adequately describes the variation among concentrations. Therefore, the lognormal model has been used routinely in the EPA development of numerous regulations in the Effluent Guidelines program and is being used in the BDAT program. The variability factor (VF) was defined as the ratio of the 99th percentile ( $C_{99}$ ) of the lognormal distribution to its arithmetic mean (Mean).

$$VF = \frac{C_{99}}{\text{Mean}} \quad (1)$$

The relationship between the parameters of the lognormal distribution and the parameters of the normal distribution created by taking the natural logarithms of the lognormally-distributed concentrations can be found in most mathematical statistics texts (see for example: Distribution in Statistics-Volume 1 by Johnson and Kotz, 1970). The mean of the lognormal distribution can be expressed in terms of the mean ( ) and standard deviation ( ) of the normal distribution as follows:

$$C_{99} = \text{Exp} ( \mu + 2.334\sigma ) \quad (2)$$

$$\text{Mean} = \text{Exp} ( \mu + .54\sigma^2 ) \quad (3)$$

Substituting (2) and (3) in (1) the variability factor can then be expressed in terms of  $\sigma$  as follows:



$$VF = \text{Exp} (2.33 \sigma - .54\sigma^2) \quad (4)$$

For residuals with concentrations that are not all below the detection limit, the 99th percentile and the mean can be estimated from the actual analytical data and accordingly, the variability factor (VF) can be estimated using equation (1). For residuals with concentrations that are below the detection limit, the above equations can be used in conjunction with the assumptions below to develop a variability factor.

Step 1: The actual concentrations follow a lognormal distribution. The upper limit (UL) is equal to the detection limit. The lower limit (LL) is assumed to be equal to one tenth of the detection limit. This assumption is based on the fact that data from well-designed and well-operated treatment systems generally falls within one order of magnitude.

Step 2: The natural logarithms of the concentrations have a normal distribution with an upper limit equal to  $\ln (UL)$  and a lower limit equal to  $\ln (LL)$ .

Step 3: The standard deviation ( $\sigma$ ) of the normal distribution is approximated by

$$\sigma = [(\ln (UL) - \ln (LL)) / [(2)(2.33)] = [\ln(UL/LL)] / 4.66$$

when  $LL = (0.1)(UL)$  then  $\sigma = (\ln 10) / 4.66 = 0.494$

Step 4: Substitution of the value from Step 3 in equation (4) yields the variability factor, VF.

$$VF = 2.8$$

## APPENDIX B - ANALYTICAL QA/QC

The analytical methods used for analysis of the regulated constituents identified in Section 5 are listed in Table B-1. SW-846 methods (EPA's Test Methods for Evaluating Solid Waste; Physical/Chemical Methods, SW-846, Third Edition, November 1986) are used in most cases for determining total waste concentrations.

Deviations from SW-846 methods required to analyze the sample matrix are listed in Table B-2. These deviations are approved methods for determining constituent concentrations. SW-846 also allows for the use of alternative or equivalent procedures or equipment; these are described in Tables B-3 through B-6. These alternatives or equivalents included use of alternative sample preparation methods and/or use of different extraction techniques to reduce sample matrix interferences.

The accuracy determination for a constituent is based on the matrix spike recovery values. Table B-7 present the matrix spike recovery values for total waste concentrations of 2-nitroaniline and 2-nitrophenol for K101 and K102, respectively, for the EPA-collected data. Because 2-nitroaniline matrix spike recoveries were not collected, the average of the percent recoveries equal to or greater than 20% for all semivolatiles was used as the

percent recovery for 2-nitroaniline. Since matrix spike recoveries for 2-nitrophenol were not available, the percent recoveries for the isomer 4-nitrophenol were used.

The accuracy correction factors for the regulated constituents for the treatment residuals are presented in Table B-7 through B-9. The accuracy correction factors were determined in accordance with the general methodology presented in the Introduction. For example, for 2-nitroaniline, the average of the actual spike recovery data for all semivolatiles obtained for the analysis of liquid matrices and the lowest average percent recovery value was used to calculate the accuracy correction factor. An example of the calculation of the corrected concentration value for 2-nitroaniline is shown below.

<u>Analytical Value</u>	<u>Average % Recovery</u>	<u>Correction Factor</u>	<u>Corrected Value</u>
2.0 mg/kg	40	$\frac{100}{40} = 2.50$	$2.50 \times 2.0 = 5.000 \text{ mg/kg}$

Table B-1 Analytical Methods for Regulated Constituents

Regulated Constituent	Analytical Method	Method Number	Reference
<u>Semivolatiles</u>			
2-Nitroaniline 2-Nitrophenol	Continuous Liquid/Liquid Extraction	3520	1
	Soxhlet Extraction	3540	1
	Gas Chromatography/Mass Spectrometry Column Technique	8270	1
<u>Metals</u>			
Antimony Arsenic Barium Cadmium Chromium Copper Nickel Zinc	Acid Digestion of Aqueous Samples and Extracts for Total Metals for Analysis by Flame Atomic Absorption Spectroscopy (AA) or Inductivity Coupled Plasma Atomic Emission Spectroscopy (ICP)	3010	1
	Acid Digestion of Aqueous Samples and Extracts for Total Metals for Analysis by Furnace Atomic Absorption Spectroscopy (AA)	3020	1
	Acid Digestion of Sediments, Sludges, and Soils	3050	1
	Acid Digestion for Metals	3060	2
	Inductively Coupled Plasma Atomic Emission Spectroscopy	6010	1
Lead	Lead (AA, Furnace Technique)	7421	1
Mercury	Mercury in Liquid Waste (Manual Cold-Vapor Technique)	7471	1
Selenium	Selenium (AA, Furnace Technique)	7740	1

1 - Environmental Protection Agency. 1986. Test Methods for Evaluating Solid Waste. Third Edition. U. S. EPA. Office of Solid Waste and Emergency Response. November 1986.

2 - Environmental Protection Agency. 1982. Test Methods for Evaluating Solid Waste. Second Edition. U. S. EPA. Office of Solid Waste and Emergency Response. September 1982.

Table 8-2 Deviations from SW-846<sup>a</sup>

Analysis	Method	SW-846 specifications	Deviation from SW-846	Rationale for deviation
1. Acid Digestion for metals analyzed	3010 3020	Digest 100 ml of sample in a conical beaker.	Initial sample volume of 50 ml is digested in Griffin straight-side beakers. All acids and peroxides are halved.	Sample volume and reagents are reduced in half; therefore, time required to reduce sample to near dryness is reduced. However, this procedure produces no impact on the precision and accuracy of the data.
2. Selenium Digestion	7740	Pipet 5 ml of digested solution into 10 ml volumetric flask; add 1 ml of the 1X nickel nitrate solution and dilute to 10 ml with Type II water. An aliquot is then injected into the instrument.	Digestate is brought to original volume and the nickel nitrate solution is added at the time of analysis. One ml of sample digestate and standards have 0.02 ml of 5X $\text{NiNO}_3$ solution added to them.	This procedure reduces time required to complete dilution procedure and produces no impact on the precision and accuracy of the data. This procedure also allows the laboratory to store only the concentrated digestates.

<sup>a</sup> - Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K101 and K102. Table 6-6.

Table B-3 Specific Procedures or Equipment Used in Extraction of Organic Compounds When Alternatives or Equivalents are Allowed in the SW-846 Methods<sup>a</sup>

Analysis	SW-846 method	Sample aliquot	Alternatives or equivalents allowed by SW-846 methods	Specific procedures or equipment used
Purge and Trap	5030	5 milliliters of liquid 1 gram of solid	<ul style="list-style-type: none"> <li>The purge and trap device to be used is specified in the method in Figure 1, the desorber to be used is described in Figures 2 and 3, and the packing materials are described in Section 4.10.2. The method allows equivalents of this equipment or materials to be used.</li> <li>The method specifies that the trap must be at least 25 cm long and have an inside diameter of at least 0.105 cm.</li> <li>The surrogates recommended are toluene-d8, 4-bromofluorobenzene, and 1,2-dichloroethane-d4. The recommended concentration level is 50 µg/l.</li> </ul>	<ul style="list-style-type: none"> <li>The purge and trap equipment and the desorber used were as specified in SW-846. The purge and trap equipment is a Teckmar LSC-2 with standard purging chambers (Supelco cat. 2-0293). The packing materials for the traps were 1/3 silica gel and 2/3 2,6-diphenylene.</li> <li>The length of the trap was 30 cm and the diameter was 0.105 cm.</li> <li>The surrogates were added as specified in SW-846.</li> </ul>
Continuous Liquid-Liquid Extraction	3520	1 liter of liquid	<ul style="list-style-type: none"> <li>Acid and base/neutral extracts are usually combined before analysis by GC/MS. Under some situations, however, they may be extracted and analyzed separately.</li> <li>The base/neutral surrogates recommended are 2-fluorobiphenyl, nitrobenzene-d5, terphenyl-d14. The acid surrogates recommended are 2-fluorophenol, 2,4,6-tribromophenol, and phenol-d6. Additional compounds</li> </ul>	<ul style="list-style-type: none"> <li>Acid and base/neutral extracts were combined.</li> <li>Surrogates were the same as those recommended by SW-846, with the exception that phenol-d5 was substituted for phenol-d6. The concentrations used were the concentrations recommended in SW-846.</li> </ul>

Table B-3 (Continued)

Analysis	SW-846 method	Sample aliquot	Alternatives or equivalents allowed by SW-846 methods	Specific procedures or equipment used
Continuous Liquid-Liquid Extraction (Continued)			may be used for surrogates. The recommended concentrations for low-medium concentration level samples are 100 ppm for acid surrogates and 200 ppm for base/neutral surrogates. Volume of surrogate may be adjusted.	
Soxhlet Extraction	3540	1 gram of solid	<ul style="list-style-type: none"> <li>The recommended surrogates and their concentrations are the same as for Method 3520.</li> <li>Sample grinding may be required for sample not passing through a 1 mm standard sieve or a 1 mm opening.</li> </ul>	<ul style="list-style-type: none"> <li>The surrogates used and their concentration levels are the same as for Method 3520.</li> <li>Sample grinding was not required.</li> </ul>

a - Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K101 and K102. Table 6-7.



Table B-4 Specific Procedures or Equipment Used in Extraction of Organic Compounds When Alternatives to SW-846 Methods Are Allowed by Approval of EPA Characterization and Assessment Division<sup>a</sup>

Analysis	SW-846 Method	Sample Aliquot	SW-846 Specification	Specific Procedures Allowed by Approval of EPA-CAD
Continuous Liquid/ Liquid Extraction or Soxhlet Extraction	3520  3540	1 liter  or 1 gram	<ul style="list-style-type: none"> <li>The internal standards are prepared by dissolution in carbon disulfide and then diluting to such volume that the final solvent is 20% carbon disulfide and 80% methylene chloride.</li> </ul>	<ul style="list-style-type: none"> <li>The preparation of the internal standards was changed to eliminate the use of carbon disulfide. The internal standards were prepared in methylene chloride only.</li> </ul>

a - Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K101 and K102. Table 6-5.

Table B-5 Special Procedures or Equipment Used for Analysis of Organic Compounds When Alternatives or Equivalents are Allowed in the SW-846 Methods<sup>a</sup>

Analysis	SW-846 method	Sample preparation method	Alternatives or equivalents allowed in SW-846 for equipment or in procedure	Specific equipment or procedures used
Gas Chromatography/ Mass Spectrometry for volatile organics	8240	5030	<ul style="list-style-type: none"> <li>Recommended GC/MS operating conditions:</li> </ul>	<ul style="list-style-type: none"> <li>Actual GC/MS operating conditions:</li> </ul>
			<ul style="list-style-type: none"> <li>Electron energy: 70 ev-(nominal)</li> <li>Mass range: 35-260 amu</li> <li>Scan time: To give 5 scans/peak but not to exceed 7 sec/scan</li> <li>Initial column temperature: 45°C</li> <li>Initial column holding time: 3 min</li> <li>Column temperature program: 8°C/min</li> <li>Final column temperature: 200°C</li> <li>Final column holding time: 15 min</li> <li>Injector temperature: 200-225°C</li> <li>Source temperature: According to manufacturer's specification</li> <li>Transfer line temperature: 250-300°C</li> <li>Carrier gas: Hydrogen at 50 cm/sec or helium at 30 cm/sec</li> </ul>	<ul style="list-style-type: none"> <li>Electron energy: 70 ev</li> <li>Mass range: 35-260 amu</li> <li>Scan time: 2.5 sec/scan</li> <li>Initial column temperature: 38°C</li> <li>Initial column holding time: 2 min</li> <li>Column temperature program: 10°C/min</li> <li>Final column temperature: 225°C</li> <li>Final column holding time: 30 min or xylene elutes</li> <li>Injector temperature: 225°C</li> <li>Source temperature: Manufacturer's recommended value of 100°C</li> <li>Transfer line temperature: 275°C</li> <li>Carrier gas: Helium @ 30 ml/min</li> </ul>
			<ul style="list-style-type: none"> <li>The column should be 6 ft x 0.1 in I.D. glass, packed with 1% SP-1000 on Carbopack B (60/80 mesh) or an equivalent.</li> <li>Samples may be analyzed by purge and trap technique or by direct injection.</li> </ul>	<ul style="list-style-type: none"> <li>Additional Information on Actual System Used: <ul style="list-style-type: none"> <li>Equipment: Finnegan model 5100 GC/MS/DS system</li> <li>Data system: SUPERINCOS Autoquan</li> <li>Mode: Electron Impact</li> <li>NBS library available</li> <li>Interface to MS - Jet separator</li> </ul> </li> <li>The column used was an 8 ft x 0.1 in I.D. glass, packed with 1% SP-1000 on Carbopack B (60/80 mesh).</li> <li>The samples were analyzed using the purge and trap technique.</li> </ul>

Table B-5 (Continued)

Analysis	SW-846 method	Sample preparation method	Alternatives or equivalents allowed in SW-846 for equipment or in procedure	Specific equipment or procedures used																																																
			<ul style="list-style-type: none"><li>Recommended GC/MS operating conditions:</li></ul>	<ul style="list-style-type: none"><li>Actual GC/MS operating conditions:</li></ul>																																																
Gas Chromatography/ Mass Spectrometry for semivolatile organics: capillary column technique	8270	3520-liquids 3520-solids	<table><tr><td>Mass range:</td><td>35-500 amu</td></tr><tr><td>Scan time:</td><td>1 sec/scan</td></tr><tr><td>Initial column temperature:</td><td>40°C</td></tr><tr><td>Initial column holding time:</td><td>4 min</td></tr><tr><td>Column temperature program:</td><td>40-270°C at 10°C/min</td></tr><tr><td>Final column temperature hold:</td><td>270°C (until benzo[g,h,i.]perylene has eluted)</td></tr><tr><td>Injector temperature:</td><td>250-300°C</td></tr><tr><td>Transfer line temperature:</td><td>250-300°C</td></tr><tr><td>Source temperature:</td><td>According to manufacturer's specification</td></tr><tr><td>Injector:</td><td>Grob-type, splitless</td></tr><tr><td>Sample volume:</td><td>1-2 µl</td></tr><tr><td>Carrier gas:</td><td>Hydrogen at 50 cm/sec or helium at 30 cm/sec</td></tr></table> <ul style="list-style-type: none"><li>The column should be 30 m by 0.25 mm I.D., 1-µm film thickness silicon-coated fused silica capillary column (J&amp;W Scientific DB-5 or equivalent).</li></ul>	Mass range:	35-500 amu	Scan time:	1 sec/scan	Initial column temperature:	40°C	Initial column holding time:	4 min	Column temperature program:	40-270°C at 10°C/min	Final column temperature hold:	270°C (until benzo[g,h,i.]perylene has eluted)	Injector temperature:	250-300°C	Transfer line temperature:	250-300°C	Source temperature:	According to manufacturer's specification	Injector:	Grob-type, splitless	Sample volume:	1-2 µl	Carrier gas:	Hydrogen at 50 cm/sec or helium at 30 cm/sec	<table><tr><td>Mass range:</td><td>35-500 amu</td></tr><tr><td>Scan time:</td><td>1 sec/scan</td></tr><tr><td>Initial column temperature:</td><td>30°C</td></tr><tr><td>Initial column holding time:</td><td>4 min</td></tr><tr><td>Column temperature program:</td><td>8°C/min to 275° and 10°C/min until 305°C</td></tr><tr><td>Final column temperature hold:</td><td>305°C</td></tr><tr><td>Injector temperature:</td><td>240-260°C</td></tr><tr><td>Transfer line temperature:</td><td>300°C</td></tr><tr><td>Source temperature:</td><td>Manufacturer's recommendation (non-heated)</td></tr><tr><td>Injector:</td><td>Grob-type, splitless</td></tr><tr><td>Sample volume:</td><td>1 µl of sample extract</td></tr><tr><td>Carrier gas:</td><td>Helium @ 40 cm/sec</td></tr></table> <ul style="list-style-type: none"><li>Additional Information on Actual System Used: Equipment: Finnegan Model 500 GC/MS/DS system Software Package: SUPERINCOS AUTOQUAN</li><li>The column used was a 30 m x 0.32 mm I.D. RT<sub>x</sub>-5 (5X phenyl methyl silicone) FSCC.</li></ul>	Mass range:	35-500 amu	Scan time:	1 sec/scan	Initial column temperature:	30°C	Initial column holding time:	4 min	Column temperature program:	8°C/min to 275° and 10°C/min until 305°C	Final column temperature hold:	305°C	Injector temperature:	240-260°C	Transfer line temperature:	300°C	Source temperature:	Manufacturer's recommendation (non-heated)	Injector:	Grob-type, splitless	Sample volume:	1 µl of sample extract	Carrier gas:	Helium @ 40 cm/sec
Mass range:	35-500 amu																																																			
Scan time:	1 sec/scan																																																			
Initial column temperature:	40°C																																																			
Initial column holding time:	4 min																																																			
Column temperature program:	40-270°C at 10°C/min																																																			
Final column temperature hold:	270°C (until benzo[g,h,i.]perylene has eluted)																																																			
Injector temperature:	250-300°C																																																			
Transfer line temperature:	250-300°C																																																			
Source temperature:	According to manufacturer's specification																																																			
Injector:	Grob-type, splitless																																																			
Sample volume:	1-2 µl																																																			
Carrier gas:	Hydrogen at 50 cm/sec or helium at 30 cm/sec																																																			
Mass range:	35-500 amu																																																			
Scan time:	1 sec/scan																																																			
Initial column temperature:	30°C																																																			
Initial column holding time:	4 min																																																			
Column temperature program:	8°C/min to 275° and 10°C/min until 305°C																																																			
Final column temperature hold:	305°C																																																			
Injector temperature:	240-260°C																																																			
Transfer line temperature:	300°C																																																			
Source temperature:	Manufacturer's recommendation (non-heated)																																																			
Injector:	Grob-type, splitless																																																			
Sample volume:	1 µl of sample extract																																																			
Carrier gas:	Helium @ 40 cm/sec																																																			

a - Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K101 and K102. Table 6-8.

Table B-6 Specific Procedures or Equipment Used in Preparation for Analysis of Metals  
When Alternatives or Equivalents are Allowed in the SW-846 Methods<sup>a</sup>

Analysis	SW-846 method	Equipment	Alternative or equivalent allowed by SW-846 methods	Specific procedures or equipment used
Inductively coupled plasma atomic emission spectroscopy	6010	Jarrell Ash 1140	<ul style="list-style-type: none"> <li>Operate equipment following instructions provided by instrument's manufacturer.</li> <li>For operation with organic solvents, auxiliary argon gas inlet is recommended.</li> </ul>	<ul style="list-style-type: none"> <li>Equipment operated using procedures specified in the Jarrell Ash (JA) 1140 Operator's Manual.</li> <li>Auxiliary argon gas was not required for sample matrix.</li> </ul>
Metals by Furnace AA				
Thallium	7841	(1) Perkin Elmer 3030	<ul style="list-style-type: none"> <li>Operate equipment following instructions provided by instrument's manufacturer.</li> </ul>	<ul style="list-style-type: none"> <li>Equipment operated using procedures specified in (1) the Perkin Elmer 3030 Instruction Manual,</li> </ul>
Selenium	7740	(2) Perkin Elmer 5000 #1		(2) the Perkin Elmer Model 5000 Instruction Manual, and
Lead	7421	(3) Perkin Elmer 5000 #2		(3) the Perkin Elmer 2580 Instruction Manual.
		(4) Perkin Elmer 2580	<ul style="list-style-type: none"> <li>For background correction, use either continuous correction or alternatives, e.g., Zeeman correction.</li> </ul>	<ul style="list-style-type: none"> <li>Background detection was used. Continuous correction on Models 2380 and 5000 #2 and Zeeman on Model 3030 and 5000 #1.</li> </ul>
			<ul style="list-style-type: none"> <li>If samples contain a large amount of organic material, they should be oxidized by conventional acid digestion before being analyzed.</li> </ul>	<ul style="list-style-type: none"> <li>Samples were prepared using acid digestion procedures from SW-846.</li> </ul>

Table B-6 (Continued)

Analysis	SW-846 method	Equipment	Alternative or equivalent allowed by SW-846 methods	Specific procedures or equipment used
Mercury	7471	Perkin Elmer 50A	<ul style="list-style-type: none"> <li>• Operate equipment following instructions provided by instrument's manufacturer.</li> <li>• Cold vapor apparatus is described in SW-846, or an equivalent apparatus may be used</li> <li>• Sample may be prepared using the water bath method or the autoclave method described in SW-846.</li> </ul>	<ul style="list-style-type: none"> <li>• Equipment operated using procedures specified in the Perkin Elmer 50A Instructions Manual.</li> <li>• Mercury was analyzed by cold vapor method using the apparatus as specified in SW-846 except there was no scrubber.</li> <li>• Samples were prepared using the water bath method.</li> </ul>

a - Onsite Engineering Report for John Zink Company, Tulsa, Oklahoma, for K101 and K102. Table 6-9.

Table 8-7 Matrix Spike Recoveries for Kiln Ash<sup>a</sup>

BDAT Constituent	Original Amount	Sample Set <sup>+</sup>			Sample Set Duplicate <sup>+</sup>			Accuracy Factor**
	Found (ug/L)	Spike Added (ug/L)	Spike Result (ug/L)	Percent Recovery*	Spike Added (ug/L)	Spike Result (ug/L)	Percent Recovery*	
<u>Semivolatile</u>								
*** 2-Nitroaniline++	---	---	---	41	---	---	40	2.50
*** 2-Nitrophenol+++	ND	200	43	22	200	42	21	4.76

a - From Onsite Engineering Report of John Zink Company, Tulsa, Oklahoma for K101 and K102. Table 6-16.

\*Percent Recovery = [(Spike Result - Original Amount)/Spike Amount] x 100.

\*\*Accuracy Correction Factor = 100/(Percent Recovery), using the lower of the two percent recovery values.

ND = Not detected. Value assumed to be zero in calculation for percent recovery.

\*\*\* = Not on BDAT List.

+ = For the matrix spike recoveries presented: Semivolatiles from Sample Set 3.

++ = The matrix spike recovery values presented for 2-nitroaniline are actually the average of the percent recoveries greater than 20% for all semivolatiles.

+++ = The matrix spike recovery values presented for 2-nitrophenol are actually for the isomer 4-nitrophenol.

Table B-8 Matrix Spike Recoveries for Treated D004 Waste <sup>a</sup>

BDAT Constituent	Original Amount Found (ug/l)	Sample Set 1			Sample Set Duplicate 1			Accuracy** Factor
		Spike Added (ug/l)	Spike Result (ug/l)	Percent* Recovery	Spike Added (ug/l)	Spike Result (ug/l)	Percent* Recovery	
<u>Metals</u>								
155. Arsenic	782	2000	3640	143	2000	3980	160	0.70
158. Cadmium	<80	500	484	97	500	471	94	1.06
161. Lead	<5	25	21	84	25	37	148	1.19
162. Mercury	0.86	5	5.6	95	5	5.6	95	1.05

<sup>a</sup> - Obtained from Onsite Engineering Report for D004. Table 6-14.

\* - Percent Recovery = [(Spike Result - Original Amount)/Spike Amount] x 100.

\*\* - Accuracy Correction Factor = 100/(Percent Recovery), using the lower of the two percent recovery values.

Table B-9 Matrix Spike Recoveries for Treated F006 Waste <sup>a</sup>

BDAT Constituent	Original Amount Found (ppm)	Duplicate (ppm)	Actual Spike (ppm)	Percent Recovery	Accuracy Correction Factor *
155. Arsenic	0.101**	0.01	0.086	94.5	1.06
	0.01***	0.01	0.068	104.0	0.96
156. Barium	0.3737	0.3326	4.9474	91.9	1.09
	0.2765	0.222	5.1462	97.9	1.02
158. Cadmium	0.0075	0.0069	4.9010	97.9	1.02
	2.9034	0.7555	6.5448	94.3	1.06
159. Chromium	0.3494	0.4226	4.6780	85.8	1.17
	0.2213	0.2653	4.5709	86.6	1.15
160. Copper	0.2247	0.2211	4.8494	92.5	1.08
	0.1526	0.1462	4.9981	97.0	1.03
161. Lead	0.3226	0.3091	4.9619	92.9	1.08
	0.2142	0.2287	4.6930	89.4	1.12
162. Mercury	0.001	0.001	0.0034	92.0	1.09
	0.001	0.001	0.0045	110.0	0.91
163. Nickel	0.028	0.0264	4.5400	90.3	1.11
	0.4742	0.0859	4.6093	86.6	1.15
164. Selenium****	0.101	0.12	0.175	86.0	1.16
	0.043	0.053	0.095	66.0	0.96
168. Zinc	0.0133	0.0238	5.0910	101.4	0.99
	27.202	3.65	19.818	87.8	1.14

a - Obtained from the Background Document for F006. Table 6-1.

\* - Accuracy Correction Factor = 100/(Percent Recovery).

\*\* - At a mix ratio of 0.5.

\*\*\* - At a mix ratio of 0.2.

\*\*\*\* - For a mix ratio of 0.2, correction factor of 1.16 was used when correcting for selenium concentrations.



TABLE C-1 DETECTION LIMITS FOR K101 BACKGROUND SCRUBBER WATER, BACKGROUND QUENCH WATER,  
AND FINAL QUENCH WATER.

, BDAT CONSTITUENT	Background	Background	Final
	Scrubber Water (mg/l)	Quench Water (mg/l)	Quench Water (mg/l)
<u>Volatile Organics</u>			
222 Acetone	0.010	0.010	0.010
1 Acetonitrile	0.100	0.100	0.100
2 Acrolein	0.100	0.100	0.100
3 Acrylonitrile	0.100	0.100	0.100
4 Benzene	0.005	0.005	0.005
5 Bromodichloromethane	0.005	0.005	0.005
6 Bromomethane	0.010	0.010	0.010
223 n-Butyl Alcohol	NA	NA	NA
7 Carbon Tetrachloride	0.005	0.005	0.005
8 Carbon Disulfide	0.005	0.005	0.005
9 Chlorobenzene	0.005	0.005	0.005
10 2-Chloro-1,3-Butadiene	0.100	0.100	0.100
11 Chlorodibromomethane	0.005	0.005	0.005
12 Chloroethane	0.010	0.010	0.010
13 2-Chloroethylvinylether	0.010	0.010	0.010
14 Chloroform	0.005	0.005	0.005
15 Chloromethane	0.010	0.010	0.010
16 3-Chloropropene	0.100	0.100	0.100
17 1,2-Dibromo-3-Chloropropane	0.010	0.010	0.010
18 1,2-Dibromoethane	0.005	0.005	0.005
19 Dibromomethane	0.005	0.005	0.005
20 Trans-1,4-Dichloro-2-Butene	0.100	0.100	0.100
21 Dichlorodifluoromethane	0.010	0.010	0.010
22 1,1-Dichloroethane	0.005	0.005	0.005
23 1,2-Dichloroethane	0.005	0.005	0.005
24 1,1-Dichloroethene	0.005	0.005	0.005
25 Trans-1,2-Dichloroethene	0.005	0.005	0.005
26 1,2-Dichloropropane	0.005	0.005	0.005
27 Trans-1,3-Dichloropropene	0.005	0.005	0.005
28 cis-1,3-Dichloropropene	0.005	0.005	0.005
29 1,4-Dioxane	0.200	0.200	0.200
224 2-Ethoxyethanol	NA	NA	NA
225 Ethyl Acetate	NA	NA	NA
226 Ethylbenzene	0.005	0.005	0.005
30 Ethyl Cyanide	0.100	0.100	0.100
227 Ethyl Ether	NA	NA	NA
31 Ethyl Methacrylate	0.100	0.100	0.100
214 Ethylene Oxide	NA	NA	NA
32 Iodomethane	0.050	0.050	0.050
33 Isobutyl Alcohol	0.200	0.200	0.200
228 Methanol	NA	NA	NA
Methyl butyl ketone	0.010	0.010	0.010
34 Methyl ethyl ketone	0.010	0.010	0.010
229 Methyl isobutyl ketone	0.010	0.010	0.010
35 Methyl Methacrylate	0.100	0.100	0.100

TABLE C-1 (Continued)

BDAT CONSTITUENT	Background	Background	Final
	Scrubber Water (mg/l)	Quench Water (mg/l)	Quench Water (mg/l)
<u>Volatile Organics (cont.)</u>			
37 Methacrylonitrile	0.100	0.100	0.100
38 Methylene Chloride	0.005	0.005	0.005
230 2-Nitropropane	NA	NA	NA
39 Pyridine	0.400	0.400	0.400
Styrene	0.005	0.005	0.005
40 1,1,1,2-Tetrachloroethane	0.005	0.005	0.005
41 1,1,2,2-Tetrachloroethane	0.005	0.005	0.005
42 Tetrachloroethene	0.005	0.005	0.005
43 Toluene	0.005	0.005	0.005
44 Tribromomethane(bromoform)	0.005	0.005	0.005
45 1,1,1-Trichloroethane	0.005	0.005	0.005
46 1,1,2-Trichloroethane	0.005	0.005	0.005
47 Trichloroethene	0.005	0.005	0.005
48 Trichloromonofluoromethane	0.005	0.005	0.005
49 1,2,3-Trichloropropane	0.005	0.005	0.005
231 1,1,2-Trichloro-1,2,2-trifluoroethane	NA	NA	NA
Vinyl Acetate	0.010	0.010	0.010
50 Vinyl Chloride	0.010	0.010	0.010
Xylenes	0.005	0.005	0.005
<u>Semivolatile Organics</u>			
51 Acenaphthalene	0.010	0.010	0.010
52 Acenaphthene	0.010	0.010	0.010
53 Acetophenone	0.020	0.020	0.020
54 2-Acetylaminofluorene	0.020	0.020	0.020
55 4-Aminobiphenyl	0.020	0.020	0.020
56 Aniline	0.010	0.010	0.010
57 Anthracene	0.010	0.010	0.010
58 Aramite	NA	NA	NA
59 Benzo(a)anthracene	0.010	0.010	0.010
218 Benzal Chloride	NA	NA	NA
60 Benzenethiol	ND	ND	ND
61 Benzidine	0.050	0.050	0.050
Benzoic Acid	0.010	0.010	0.010
62 Benzo(a)pyrene	0.010	0.010	0.010
63 Benzo(b)fluoranthene	0.010	0.010	0.010
64 Benzo(g,h,i) perylene	0.010	0.010	0.010
65 Benzo(k)fluoranthene	0.010	0.010	0.010
66 p-Benzoquinone	ND	ND	ND
Benzyl Alcohol	0.010	0.010	0.010
67 Bis(2-Chloroethoxy) methane	0.010	0.010	0.010
68 Bis(2-Chloroethyl) Ether	0.010	0.010	0.010
69 Bis(2-chloroisopropyl) ether	0.010	0.010	0.010
70 Bis(2-ethylhexyl) phthalate	0.010	0.010	0.010
71 4-Bromophenyl phenyl ether	0.010	0.010	0.010

TABLE C-1 (Continued)

BDAT CONSTITUENT	Background	Background	Final
	Scrubber	Quench	Quench
	Water (mg/l)	Water (mg/l)	Water (mg/l)
<u>Semivolatile Organics (cont.)</u>			
72 Butyl benzyl phthalate	0.010	0.010	0.010
73 2-Sec-Butyl-4,6-Dinitrophenol	0.050	0.050	0.050
74 p-Chloroaniline	0.010	0.010	0.010
75 Chlorobenzilate	NA	NA	NA
76 p-Chloro-m-cresol	0.010	0.010	0.010
77 2-Chloronaphthalene	0.010	0.010	0.010
78 2-Chlorophenol	0.010	0.010	0.010
4-Chlorophenyl-phenyl ether	0.010	0.010	0.010
79 3-Chloropropionitrile	NA	NA	NA
80 Chrysene	0.010	0.010	0.010
81 Ortho-cresol	0.010	0.010	0.010
82 para-cresol	0.010	0.010	0.010
232 Cyclohexanone	ND	ND	ND
83 Dibenz(a,h)anthracene	0.010	0.010	0.010
Dibenzofuran	0.010	0.010	0.010
84 Dibenzo(a,e,) Pyrene	NA	NA	NA
85 Dibenzo(a,i) Pyrene	NA	NA	NA
86 1,3-Dichlorobenzene	0.010	0.010	0.010
87 1,2-Dichlorobenzene	0.010	0.010	0.010
88 1,4-Dichlorobenzene	0.010	0.010	0.010
89 3,3'-Dichlorobenzidine	0.020	0.020	0.020
90 2,4-Dichlorophenol	0.010	0.010	0.010
91 2,6-Dichlorophenol	ND	ND	ND
92 Diethyl phthalate	0.010	0.010	0.010
93 3,3'-Dimethoxybenzidine	0.010	0.010	0.010
94 p-Dimethylaminoazobenzene	0.020	0.020	0.020
95 3,3'-Dimethylbenzidine	ND	ND	ND
96 2,4-Dimethylphenol	0.010	0.010	0.010
97 Dimethyl Phthalate	0.010	0.010	0.010
98 Di-n-butyl phthalate	0.010	0.010	0.010
99 1,4-Dinitrobenzene	0.050	0.050	0.050
100 4,6-dinitro-o-cresol	0.050	0.050	0.050
101 2,4-Dinitrophenol	0.050	0.050	0.050
102 2,4-Dinitrotoluene	0.010	0.010	0.010
103 2,6-Dinitrotoluene	0.010	0.010	0.010
104 Di-n-octyl phthalate	0.010	0.010	0.010
105 Di-n-propylnitrosoamine	0.010	0.010	0.010
106 Diphenylamine (1)	0.020	0.020	0.020
107 1,2,-Diphenylhydrazine	0.050	0.050	0.050
108 Fluoranthene	0.010	0.010	0.010
109 Fluorene	0.010	0.010	0.010
110 Hexachlorobenzene	0.010	0.010	0.010
111 Hexachlorobutadiene	0.010	0.010	0.010
112 Hexachlorocyclopentadiene	0.010	0.010	0.010
113 Hexachloroethane	0.010	0.010	0.010
114 Hexachlorophene	NA	NA	NA

TABLE C-1 (Continued)

BDAT CONSTITUENT	Background Scrubber Water (mg/l)	Background Quench Water (mg/l)	Final Quench Water (mg/l)
<u>Semivolatile Organics (cont.)</u>			
115 Hexachloropropene	ND	ND	ND
116 Indeno(1,2,3,-cd) Pyrene	0.010	0.010	0.010
117 Isosafrole	0.020	0.020	0.020
Isophorone	0.010	0.010	0.010
118 Methapyrilene	NA	NA	NA
119 3-Methylcholanthrene	0.020	0.020	0.020
120 4,4'-Methylene-bis-(2-chloroaniline)	0.020	0.020	0.020
36 Methyl Methanesulfonate	ND	ND	ND
2-Methyl naphthalene	0.010	0.010	0.010
121 Naphthalene	0.010	0.010	0.010
122 1,4-Naphthoquinone	NA	NA	NA
123 1-Naphthylamine	0.050	0.050	0.050
124 2-Naphthylamine	0.050	0.050	0.050
2-Nitroaniline	0.050	0.050	0.050
3-Nitroaniline	0.050	0.050	0.050
125 p-Nitroaniline	0.050	0.050	0.050
126 Nitrobenzene	0.010	0.010	0.010
2-Nitrophenol	0.010	0.010	0.010
127 4-Nitrophenol	0.050	0.050	0.050
128 N-Nitrosodi-n-butylamine	ND	ND	ND
129 N-Nitrosodiethylamine	ND	ND	ND
130 N-Nitrosodimethylamine	0.010	0.010	0.010
131 N-Nitrosomethylethylamine	0.010	0.010	0.010
132 N-Nitrosomorpholine	0.020	0.020	0.020
219 N-Nitrosodiphenylamine (1)	0.010	0.010	0.010
133 1-Nitrosopiperidine	0.010	0.010	0.010
134 N-Nitrosopyrrolidine	0.050	0.050	0.050
135 2-Methyl-5-nitroaniline	0.020	0.020	0.020
136 Pentachlorobenzene	ND	ND	ND
137 Pentachloroethane	NA	NA	NA
138 Pentachloronitrobenzene	0.100	0.100	0.100
139 Pentachlorophenol	0.050	0.050	0.050
140 Phenacetin	0.020	0.020	0.020
141 Phenanthrene	0.010	0.010	0.010
142 Phenol	0.010	0.010	0.010
220 Phthalic Anhydride	ND	ND	ND
143 2-Picoline	0.010	0.010	0.010
144 Pronamide	ND	ND	ND
145 Pyrene	0.010	0.010	0.010
146 Resorcinol	NA	NA	NA
147 Safrole	0.050	0.050	0.050
148 1,2,4,5-Tetrachlorobenzene	0.020	0.020	0.020
149 2,3,4,6-Tetrachlorophenol	ND	ND	ND
150 1,2,4-Trichlorobenzene	0.010	0.010	0.010
151 2,4,5-Trichlorophenol	0.050	0.050	0.050
152 2,4,6-Trichlorophenol	0.010	0.010	0.010
153 Tris(2,3-dibromopropyl) phosphate	ND	ND	ND

TABLE C-1 (Continued)

BDAT CONSTITUENT	Background Scrubber Water (mg/l)	Background Quench Water (mg/l)	Final Quench Water (mg/l)
<u>Metals - Total Composition</u>			
154 Antimony	0.330	0.033	0.033
155 Arsenic	0.280	0.028	0.028
156 Barium	0.002	0.002	0.002
157 Beryllium	0.001	0.001	0.001
158 Cadmium	0.050	0.050	0.005
159 Chromium	0.004	0.004	0.004
221 Hexavalent Chromium	0.010	0.010	0.010
160 Copper	0.005	0.005	0.005
161 Lead	1.250	0.050	0.005
162 Mercury	0.002	0.0002	0.0002
163 Nickel	0.011	0.011	0.011
164 Selenium	0.250	0.050	0.005
165 Silver	0.007	0.007	0.007
166 Thallium	0.100	0.010	0.010
167 Vanadium	0.004	0.004	0.004
168 Zinc	0.004	0.004	0.004
<u>Metals - TCLP</u>			
154 Antimony			
155 Arsenic			
156 Barium			
157 Beryllium		NOT	
158 Cadmium			
159 Chromium			
160 Copper			ANALYZED
161 Lead			
162 Mercury			
163 Nickel			
164 Selenium			
165 Silver			
166 Thallium			
167 Vanadium			
168 Zinc			
<u>Inorganics</u>			
169 Cyanide	0.010	0.010	0.010
170 Fluoride	0.2	0.2	0.2
171 Sulfide	0.5	0.5	0.5
<u>Other Parameters</u>			
Chlorides	1	1	1
Sulfates	5	5	5

(1) - Cannot be separated from N-Nitrosodiphenylamine.

NA - The standard is not available; compound was searched using an NBS library of 42,000 compounds.

ND - Not detected, estimated detection limit has not been determined.

TABLE C-2 DETECTION LIMITS FOR K101 SAMPLE SET #1

BOAT CONSTITUENT		Untreated Waste to Incinerator (mg/kg)	Treated Waste (Slag) (mg/kg)	Scrubber Wastewater (mg/l)
<u>Volatile Organics</u>				
222	Acetone	50	0.010	0.010
1	Acetonitrile	500	0.100	0.100
2	Acrolein	500	0.100	0.100
3	Acrylonitrile	500	0.100	0.100
4	Benzene	25	0.005	0.005
5	Bromodichloromethane	25	0.005	0.005
6	Bromomethane	50	0.010	0.010
223	n-Butyl Alcohol	NA	NA	NA
7	Carbon Tetrachloride	25	0.005	0.005
8	Carbon Disulfide	25	0.005	0.005
9	Chlorobenzene	25	0.005	0.005
10	2-Chloro-1,3-Butadiene	500	0.100	0.100
11	Chlorodibromomethane	25	0.005	0.005
12	Chloroethane	50	0.010	0.010
13	2-Chloroethylvinylether	50	0.010	0.010
14	Chloroform	25	0.005	0.005
15	Chloromethane	50	0.010	0.010
16	3-Chloropropene	500	0.100	0.100
17	1,2-Dibromo-3-Chloropropane	50	0.010	0.010
18	1,2-Dibromoethane	25	0.005	0.005
19	Dibromomethane	25	0.005	0.005
20	Trans-1,4-Dichloro-2-Butene	500	0.100	0.100
21	Dichlorodifluoromethane	50	0.010	0.010
22	1,1-Dichloroethane	25	0.005	0.005
23	1,2-Dichloroethane	25	0.005	0.005
24	1,1-Dichloroethene	25	0.005	0.005
25	Trans-1,2-Dichloroethene	25	0.005	0.005
26	1,2-Dichloropropane	25	0.005	0.005
27	Trans-1,3-Dichloropropene	25	0.005	0.005
28	cis-1,3-Dichloropropene	25	0.005	0.005
29	1,4-Dioxane	1000	0.200	0.200
224	2-Ethoxyethanol	NA	NA	NA
225	Ethyl Acetate	NA	NA	NA
226	Ethylbenzene	25	0.005	0.005
30	Ethyl Cyanide	500	0.100	0.100
227	Ethyl Ether	NA	NA	NA
31	Ethyl-Methacrylate	500	0.100	0.100
214	Ethylene Oxide	NA	NA	NA
32	Iodomethane	250	0.050	0.050
33	Isobutyl Alcohol	1000	0.200	0.200
	Methyl butyl ketone	50	0.010	0.010
34	Methyl ethyl ketone	50	0.010	0.010
229	Methyl isobutyl ketone	50	0.010	0.010
35	Methyl Methacrylate	500	0.100	0.100

TABLE C-2 (Continued)

BDAT CONSTITUENT		Untreated Waste to Incinerator (mg/kg)	Treated Waste (Slag) (mg/kg)	Scrubber Wastewater (mg/l)
<u>Volatile Organics (cont.)</u>				
37	Methacrylonitrile	500	0.100	0.100
38	Methylene Chloride	25	0.005	0.005
230	2-Nitropropane	NA	NA	NA
39	Pyridine	2000	0.400	0.400
	Styrene	25	0.005	0.005
40	1,1,1,2-Tetrachloroethane	25	0.005	0.005
41	1,1,2,2-Tetrachloroethane	25	0.005	0.005
42	Tetrachloroethene	25	0.005	0.005
43	Toluene	25	0.005	0.005
44	Tribromomethane(bromoform)	25	0.005	0.005
45	1,1,1-Trichloroethane	25	0.005	0.005
46	1,1,2-Trichloroethane	25	0.005	0.005
47	Trichloroethene	25	0.005	0.005
48	Trichloromonofluoromethane	25	0.005	0.005
49	1,2,3-Trichloropropane	25	0.005	0.005
231	1,1,2-Trichloro-1,2,2-trifluoroethane	NA	NA	NA
	Vinyl Acetate	50	0.010	0.010
50	Vinyl Chloride	50	0.010	0.010
	Xylenes	25	0.005	0.005
<u>Semivolatile Organics</u>				
51	Acenaphthalene	36000	0.420	0.010
52	Acenaphthene	36000	0.420	0.010
53	Acetophenone	72000	0.840	0.020
54	2-Acetylaminofluorene	72000	0.840	0.020
55	4-Aminobiphenyl	72000	0.840	0.020
56	Aniline	36000	0.420	0.010
57	Anthracene	36000	0.420	0.010
58	Aramite	NA	NA	NA
59	Benzo(a)anthracene	36000	0.420	0.010
218	Benzal Chloride	NA	NA	NA
60	Benzenethiol	ND	ND	ND
61	Benzidine	180000	2.1	0.050
	Benzoic Acid	178000	2	0.010
62	Benzo(a)pyrene	36000	0.420	0.010
63	Benzo(b)fluoranthene	36000	0.420	0.010
64	Benzo(g,h,i) perylene	36000	0.420	0.010
65	Benzo(k)fluoranthene	36000	0.420	0.010
66	p-Benzoquinone	ND	ND	ND
	Benzyl Alcohol	36000	0.420	0.010
67	Bis(2-Chloroethoxy) methane	36000	0.420	0.010
68	Bis(2-Chloroethyl) Ether	36000	0.420	0.010
69	Bis(2-chloroisopropyl) ether	36000	0.420	0.010
70	Bis(2-ethylhexyl) phthalate	36000	0.420	0.010
71	4-Bromophenyl phenyl ether	36000	0.420	0.010

TABLE C-2 (Continued)

BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Slag) (mg/kg)	Scrubber Wastewater (mg/l)
<u>Semivolatile Organics (cont.)</u>			
72 Butyl benzyl phthalate	36000	0.420	0.010
73 2-Sec-Butyl-4,6-Dinitrophenol	180000	2.1	0.050
74 p-Chloroaniline	36000	0.420	0.010
75 Chlorobenzilate	NA	NA	NA
76 p-Chloro-m-cresol	36000	0.420	0.010
77 2-Chloronaphthalene	36000	0.420	0.010
78 2-Chlorophenol	36000	0.420	0.010
4-Chlorophenyl-phenyl ether	36000	0.420	0.010
79 3-Chloropropionitrile	NA	NA	NA
80 Chrysene	36000	0.420	0.010
81 Ortho-cresol	36000	0.420	0.010
82 para-cresol	36000	0.420	0.010
232 Cyclohexanone	ND	ND	ND
83 Dibenz(a,h)anthracene	36000	0.420	0.010
Dibenzofuran	36000	0.420	0.010
84 Dibenzo(a,e,) Pyrene	NA	NA	NA
85 Dibenzo(a,i) Pyrene	NA	NA	NA
86 1,3-Dichlorobenzene	36000	0.420	0.010
87 1,2-Dichlorobenzene	36000	0.420	0.010
88 1,4-Dichlorobenzene	36000	0.420	0.010
89 3,3'-Dichlorobenzidine	72000	0.840	0.020
90 2,4-Dichlorophenol	36000	0.420	0.010
91 2,6-Dichlorophenol	ND	ND	ND
92 Diethyl phthalate	36000	0.420	0.010
93 3,3'-Dimethoxybenzidine	36000	0.420	0.010
94 p-Dimethylaminoazobenzene	72000	0.840	0.020
95 3,3'-Dimethylbenzidine	ND	ND	ND
96 2,4-Dimethylphenol	36000	0.420	0.010
97 Dimethyl Phthalate	36000	0.420	0.010
98 Di-n-butyl phthalate	36000	0.420	0.010
99 1,4-Dinitrobenzene	180000	2.1	0.050
100 4,6-dinitro-o-cresol	178000	2	0.050
101 2,4-Dinitrophenol	178000	2	0.050
102 2,4-Dinitrotoluene	36000	0.420	0.010
103 2,6-Dinitrotoluene	36000	0.420	0.010
104 Di-n-octyl phthalate	36000	0.420	0.010
105 Di-n-propylnitrosoamine	36000	0.420	0.010
106 Diphenylamine (1)	72000	0.840	0.020
107 1,2,-Diphenylhydrazine	180000	2.1	0.050
108 Fluoranthene	36000	0.420	0.010
109 Fluorene	36000	0.420	0.010
110 Hexachlorobenzene	36000	0.420	0.010
111 Hexachlorobutadiene	36000	0.420	0.010
112 Hexachlorocyclopentadiene	36000	0.420	0.010
113 Hexachloroethane	36000	0.420	0.010
114 Hexachlorophene	NA	NA	NA



TABLE C-2 (Continued)

BOAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Slag) (mg/kg)	Scrubber Wastewater (mg/l)
<u>Semivolatile Organics (cont.)</u>			
115 Hexachloropropene	ND	ND	ND
116 Indeno(1,2,3,-cd) Pyrene	36000	0.420	0.010
117 Isosafrole	72000	0.840	0.020
Isophorone	36000	0.420	0.010
118 Methapyrilene	NA	NA	NA
119 3-Methylcholanthrene	72000	0.840	0.020
120 4,4'-Methylene-bis-(2-chloroaniline)	72000	0.840	0.020
36 Methyl Methanesulfonate	ND	ND	ND
2-Methyl naphthalene	36000	0.420	0.010
121 Naphthalene	36000	0.420	0.010
122 1,4-Naphthoquinone	NA	NA	NA
123 1-Naphthylamine	180000	2.1	0.050
124 2-Naphthylamine	180000	2.1	0.050
2-Nitroaniline	178000	2	0.050
3-Nitroaniline	178000	2	0.050
125 p-Nitroaniline	178000	2	0.050
126 Nitrobenzene	36000	0.420	0.010
2-Nitrophenol	36000	0.420	0.010
127 4-Nitrophenol	178000	2	0.050
128 N-Nitrosodi-n-butylamine	ND	ND	ND
129 N-Nitrosodiethylamine	ND	ND	ND
130 N-Nitrosodimethylamine	36000	0.420	0.010
131 N-Nitrosomethylethylamine	36000	0.420	0.010
132 N-Nitrosomorpholine	36000	0.420	0.020
219 N-Nitrosodiphenylamine (1)	72000	0.840	0.010
133 1-Nitrosopiperidine	36000	0.420	0.010
134 N-Nitrosopyrrolidine	180000	2.1	0.050
135 2-Methyl-5-nitroaniline	72000	0.840	0.020
136 Pentachlorobenzene	ND	NQ	ND
137 Pentachloroethane	NA	NA	NA
138 Pentachloronitrobenzene	360000	4.2	0.100
139 Pentachlorophenol	178000	2	0.050
140 Phenacetin	72000	0.840	0.020
141 Phenanthrene	36000	0.420	0.010
142 Phenol	36000	0.420	0.010
220 Phthalic Anhydride	ND	ND	ND
143 2-Picoline	36000	0.420	0.010
144 Pronamide	ND	ND	ND
145 Pyrene	36000	0.420	0.010
146 Resorcinol	NA	NA	NA
147 Safrole	180000	2.1	0.050
148 1,2,4,5-Tetrachlorobenzene	72000	0.840	0.020
149 2,3,4,6-Tetrachlorophenol	ND	ND	ND
150 1,2,4-Trichlorobenzene	36000	0.420	0.010
151 2,4,5-Trichlorophenol	178000	2	0.050
152 2,4,6-Trichlorophenol	36000	0.420	0.010
153 Tris(2,3-dibromopropyl) phosphate	ND	ND	ND

TABLE C-2 (Continued)

BOAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Slag) (mg/kg)	Scrubber Wastewater (mg/l)
<u>Metals - Total Composition</u>			
154 Antimony	3.3	3.3	0.330
155 Arsenic	2.8	100	0.280
156 Barium	0.2	0.2	0.002
157 Beryllium	0.1	0.1	0.001
158 Cadmium	5.0	0.5	0.050
159 Chromium	0.4	0.4	0.004
221 Hexavalent Chromium	0.01	0.01	0.010
160 Copper	0.5	0.5	0.005
161 Lead	0.5	0.5	0.750
162 Mercury	0.02	0.02	0.0008
163 Nickel	1.1	1.1	0.011
164 Selenium	0.5	0.5	0.050
165 Silver	0.7	0.7	0.007
166 Thallium	5.0	1.0	0.100
167 Vanadium	0.4	0.4	0.004
168 Zinc	0.4	0.4	0.004
<u>Metals - TCLP (mg/l)</u>			
154 Antimony		0.033	
155 Arsenic		0.200	
156 Barium		0.002	
157 Beryllium	NOT	0.001	NOT
158 Cadmium		0.005	
159 Chromium		0.004	
160 Copper	ANALYZED	0.005	ANALYZED
161 Lead		0.005	
162 Mercury		0.0002	
163 Nickel		0.011	
164 Selenium		0.005	
165 Silver		0.007	
166 Thallium		0.010	
167 Vanadium		0.004	
168 Zinc		0.004	
<u>Inorganics</u>			
169 Cyanide	0.010	0.010	0.010
170 Fluoride	0.2	0.2	0.2
171 Sulfide	0.5	0.5	0.5
<u>Other Parameters</u>			
Chlorides	1	1	1
Sulfates	5	5	5

(1) - Cannot be separated from N-Nitrosodiphenylamine.

NA - The standard is not available; compound was searched using an NBS library of 42,000 compounds.

ND - Not detected, estimated detection limit has not been determined.

TABLE C-3 DETECTION LIMITS FOR K101 SAMPLE SET #2

BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Slag) (mg/kg)	Scrubber Wastewater (mg/l)
<u>Volatile Organics</u>			
222 Acetone	50	0.010	0.010
1 Acetonitrile	500	0.100	0.100
2 Acrolein	500	0.100	0.100
3 Acrylonitrile	500	0.100	0.100
4 Benzene	25	0.005	0.005
5 Bromodichloromethane	25	0.005	0.005
6 Bromomethane	50	0.010	0.010
223 n-Butyl Alcohol	NA	NA	NA
7 Carbon Tetrachloride	25	0.005	0.005
8 Carbon Disulfide	25	0.005	0.005
9 Chlorobenzene	25	0.005	0.005
10 2-Chloro-1,3-Butadiene	500	0.100	0.100
11 Chlorodibromomethane	25	0.005	0.005
12 Chloroethane	50	0.010	0.010
13 2-Chloroethylvinylether	50	0.010	0.010
14 Chloroform	25	0.005	0.005
15 Chloromethane	50	0.010	0.010
16 3-Chloropropene	500	0.100	0.100
17 1,2-Dibromo-3-Chloropropane	50	0.010	0.010
18 1,2-Dibromoethane	25	0.005	0.005
19 Dibromomethane	25	0.005	0.005
20 Trans-1,4-Dichloro-2-Butene	500	0.100	0.100
21 Dichlorodifluoromethane	50	0.010	0.010
22 1,1-Dichloroethane	25	0.005	0.005
23 1,2-Dichloroethane	25	0.005	0.005
24 1,1-Dichloroethene	25	0.005	0.005
25 Trans-1,2-Dichloroethene	25	0.005	0.005
26 1,2-Dichloropropane	25	0.005	0.005
27 Trans-1,3-Dichloropropene	25	0.005	0.005
28 cis-1,3-Dichloropropene	25	0.005	0.005
29 1,4-Dioxane	1000	0.200	0.200
224 2-Ethoxyethanol	NA	NA	NA
225 Ethyl Acetate	NA	NA	NA
226 Ethylbenzene	25	0.005	0.005
30 Ethyl Cyanide	500	0.100	0.100
227 Ethyl Ether	NA	NA	NA
31 Ethyl Methacrylate	500	0.100	0.100
214 Ethylene Oxide	NA	NA	NA
32 Iodomethane	250	0.050	0.050
33 Isobutyl Alcohol	1000	0.200	0.200
228 Methanol	NA	NA	NA
Methyl butyl ketone	50	0.010	0.010
34 Methyl ethyl ketone	50	0.010	0.010
229 Methyl isobutyl ketone	50	0.010	0.010
35 Methyl Methacrylate	500	0.100	0.100

TABLE C-3 (Continued)

BOAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Slag) (mg/kg)	Scrubber Wastewater (mg/l)
<u>Volatile Organics (cont.)</u>			
37 Methacrylonitrile	500	0.100	0.100
38 Methylene Chloride	25	0.005	0.005
230 2-Nitropropane	NA	NA	NA
39 Pyridine	2000	0.400	0.400
Styrene	25	0.005	0.005
40 1,1,1,2-Tetrachloroethane	25	0.005	0.005
41 1,1,2,2-Tetrachloroethane	25	0.005	0.005
42 Tetrachloroethene	25	0.005	0.005
43 Toluene	25	0.005	0.005
44 Tribromomethane(bromofom)	25	0.005	0.005
45 1,1,1-Trichloroethane	25	0.005	0.005
46 1,1,2-Trichloroethane	25	0.005	0.005
47 Trichloroethene	25	0.005	0.005
48 Trichloromonofluoromethane	25	0.005	0.005
49 1,2,3-Trichloropropane	25	0.005	0.005
231 1,1,2-Trichloro-1,2,2-trifluoroethane	NA	NA	NA
Vinyl Acetate	50	0.010	0.010
50 Vinyl Chloride	50	0.010	0.010
Xylenes	25	0.005	0.005
<u>Semivolatile Organics</u>			
51 Acenaphthalene	38000	0.420	0.010
52 Acenaphthene	38000	0.420	0.010
53 Acetophenone	76000	0.840	0.020
54 2-Acetylaminofluorene	76000	0.840	0.020
55 4-Aminobiphenyl	76000	0.840	0.020
56 Aniline	38000	0.420	0.010
57 Anthracene	38000	0.420	0.010
58 Aramite	NA	NA	NA
59 Benzo(a)anthracene	38000	0.420	0.010
218 Benzal Chloride	NA	NA	NA
60 Benzenethiol	ND	ND	ND
61 Benzidine	190000	2.1	0.050
Benzoic Acid	188000	2	0.010
62 Benzo(a)pyrene	38000	0.420	0.010
63 Benzo(b)fluoranthene	38000	0.420	0.010
64 Benzo(g,h,i) perylene	38000	0.420	0.010
65 Benzo(k)fluoranthene	38000	0.420	0.010
66 p-Benzoquinone	ND	ND	ND
Benzyl Alcohol	38000	0.420	0.010
67 Bis(2-Chloroethoxy) methane	38000	0.420	0.010
68 Bis(2-Chloroethyl) Ether	38000	0.420	0.010
69 Bis(2-chloroisopropyl) ether	38000	0.420	0.010
70 Bis(2-ethylhexyl) phthalate	38000	0.420	0.010
71 4-Bromophenyl phenyl ether	38000	0.420	0.010

TABLE C-3 (Continued)

BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Slag) (mg/kg)	Scrubber Wastewater (mg/L)
<u>Semivolatile Organics (cont.)</u>			
72 Butyl benzyl phthalate	38000	0.420	0.010
73 2-Sec-Butyl-4,6-Dinitrophenol	190000	2.1	0.050
74 p-Chloroaniline	38000	0.420	0.010
75 Chlorobenzilate	NA	NA	NA
76 p-Chloro-m-cresol	38000	0.420	0.010
77 2-Chloronaphthalene	38000	0.420	0.010
78 2-Chlorophenol	38000	0.420	0.010
4-Chlorophenyl-phenyl ether	38000	0.420	0.010
79 3-Chloropropionitrile	NA	NA	NA
80 Chrysene	38000	0.420	0.010
81 Ortho-cresol	38000	0.420	0.010
82 para-cresol	38000	0.420	0.010
232 Cyclohexanone	ND	ND	ND
83 Dibenz(a,h)anthracene	38000	0.420	0.010
Dibenzofuran	38000	0.420	0.010
84 Dibenzo(a,e,) Pyrene	NA	NA	NA
85 Dibenzo(a,i) Pyrene	NA	NA	NA
86 1,3-Dichlorobenzene	38000	0.420	0.010
87 1,2-Dichlorobenzene	38000	0.420	0.010
88 1,4-Dichlorobenzene	38000	0.420	0.010
89 3,3'-Dichlorobenzidine	76000	0.840	0.020
90 2,4-Dichlorophenol	38000	0.420	0.010
91 2,6-Dichlorophenol	ND	ND	ND
92 Diethyl phthalate	38000	0.420	0.010
93 3,3'-Dimethoxybenzidine	38000	0.420	0.010
94 p-Dimethylaminoazobenzene	76000	0.840	0.020
95 3,3'-Dimethylbenzidine	ND	ND	ND
96 2,4-Dimethylphenol	38000	0.420	0.010
97 Dimethyl Phthalate	38000	0.420	0.010
98 Di-n-butyl phthalate	38000	0.420	0.010
99 1,4-Dinitrobenzene	190000	2.1	0.050
100 4,6-dinitro-o-cresol	188000	2	0.050
101 2,4-Dinitrophenol	188000	2	0.050
102 2,4-Dinitrotoluene	38000	0.420	0.010
103 2,6-Dinitrotoluene	38000	0.420	0.010
104 Di-n-octyl phthalate	38000	0.420	0.010
105 Di-n-propylnitrosoamine	38000	0.420	0.010
106 Diphenylamine (1)	76000	0.840	0.020
107 1,2,-Diphenylhydrazine	190000	2.1	0.050
108 Fluoranthene	38000	0.420	0.010
109 Fluorene	38000	0.420	0.010
110 Hexachlorobenzene	38000	0.420	0.010
111 Hexachlorobutadiene	38000	0.420	0.010
112 Hexachlorocyclopentadiene	38000	0.420	0.010
113 Hexachloroethane	38000	0.420	0.010
114 Hexachlorophene	NA	NA	NA

TABLE C-3 (Continued)

BOAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Slag) (mg/kg)	Scrubber Wastewater (mg/l)
<u>Semivolatile Organics (cont.)</u>			
115 Hexachloropropene	ND	ND	ND
116 Indeno(1,2,3,-cd) Pyrene	38000	0.420	0.010
117 Isosafrole	76000	0.840	0.020
Isophorone	38000	0.420	0.010
118 Methapyrilene	NA	NA	NA
119 3-Methylcholanthrene	76000	0.840	0.020
120 4,4'-Methylene-bis-(2-chloroaniline)	76000	0.840	0.020
36 Methyl Methanesulfonate	ND	ND	ND
2-Methyl naphthalene	36000	0.420	0.010
121 Naphthalene	36000	0.420	0.010
122 1,4-Naphthoquinone	NA	NA	NA
123 1-Naphthylamine	180000	2.1	0.050
124 2-Naphthylamine	180000	2.1	0.050
2-Nitroaniline	178000	2	0.050
3-Nitroaniline	178000	2	0.050
125 p-Nitroaniline	178000	2	0.050
126 Nitrobenzene	38000	0.420	0.010
2-Nitrophenol	38000	0.420	0.010
127 4-Nitrophenol	188000	2	0.050
128 N-Nitrosodi-n-butylamine	ND	ND	ND
129 N-Nitrosodiethylamine	ND	ND	ND
130 N-Nitrosodimethylamine	38000	0.420	0.010
131 N-Nitrosomethylethylamine	38000	0.420	0.010
132 N-Nitrosomorpholine	38000	0.420	0.020
219 N-Nitrosodiphenylamine (1)	76000	0.840	0.010
133 1-Nitrosopiperidine	38000	0.420	0.010
134 N-Nitrosopyrrolidine	190000	2.1	0.050
135 2-Methyl-5-nitroaniline	76000	0.840	0.020
136 Pentachlorobenzene	ND	NQ	ND
137 Pentachloroethane	NA	NA	NA
138 Pentachloronitrobenzene	380000	4.2	0.100
139 Pentachlorophenol	188000	2	0.050
140 Phenacetin	76000	0.840	0.020
141 Phenanthrene	38000	0.420	0.010
142 Phenol	38000	0.420	0.010
220 Phthalic Anhydride	ND	ND	ND
143 2-Picoline	38000	0.420	0.010
144 Pronamide	ND	ND	ND
145 Pyrene	38000	0.420	0.010
146 Resorcinol	NA	NA	NA
147 Safrole	190000	2.1	0.050
148 1,2,4,5-Tetrachlorobenzene	76000	0.840	0.020
149 2,3,4,6-Tetrachlorophenol	ND	ND	ND
150 1,2,4-Trichlorobenzene	38000	0.420	0.010
151 2,4,5-Trichlorophenol	188000	2	0.050
152 2,4,6-Trichlorophenol	38000	0.420	0.010
153 Tris(2,3-dibromopropyl) phosphate	ND	ND	ND

TABLE C-3 (Continued)

BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Slag) (mg/kg)	Scrubber Wastewater (mg/L)
<u>Metals - Total Composition</u>			
154 Antimony	3.3	3.3	0.330
155 Arsenic	2.8	100	0.280
156 Barium	0.2	0.2	0.002
157 Beryllium	0.1	0.1	0.001
158 Cadmium	5.0	0.5	0.500
159 Chromium	0.4	0.4	0.004
221 Hexavalent Chromium	0.01	0.01	0.010
160 Copper	0.5	0.5	0.005
161 Lead	2.0	0.5	0.750
162 Mercury	0.02	0.1	0.004
163 Nickel	1.1	1.1	0.011
164 Selenium	5.0	0.5	0.025
165 Silver	0.7	0.7	0.007
166 Thallium	5.0	1.0	0.020
167 Vanadium	0.4	0.4	0.004
168 Zinc	0.4	0.4	0.004
<u>Metals - TCLP (mg/L)</u>			
154 Antimony		0.033	
155 Arsenic		0.200	
156 Barium		0.002	
157 Beryllium	NOT	0.001	NOT
158 Cadmium		0.005	
159 Chromium		0.004	
160 Copper	ANALYZED	0.005	ANALYZED
161 Lead		0.005	
162 Mercury		0.0002	
163 Nickel		0.011	
164 Selenium		0.010	
165 Silver		0.007	
166 Thallium		0.010	
167 Vanadium		0.004	
168 Zinc		0.004	
<u>Inorganics</u>			
169 Cyanide	0.010	0.010	0.010
170 Fluoride	0.2	0.2	0.2
171 Sulfide	0.5	0.5	0.5
<u>Other Parameters</u>			
Chlorides	1	1	1
Sulfates	5	5	5

(1) - Cannot be separated from N-Nitrosodiphenylamine.

NA - The standard is not available; compound was searched using an NBS library of 42,000 compounds.

ND - Not detected, estimated detection limit has not been determined.

TABLE C-4 DETECTION LIMITS FOR K101 SAMPLE SET #3

BDAT CONSTITUENT	Untreated	Treated	Scrubber
	Waste to Incinerator (mg/kg)	Waste (Slag) (mg/kg)	Wastewater (mg/l)
<u>Volatile Organics</u>			
222 Acetone	50	0.010	0.010
1 Acetonitrile	500	0.100	0.100
2 Acrolein	500	0.100	0.100
3 Acrylonitrile	500	0.100	0.100
4 Benzene	25	0.005	0.005
5 Bromodichloromethane	25	0.005	0.005
6 Bromomethane	50	0.010	0.010
223 n-butyl Alcohol	NA	NA	NA
7 Carbon Tetrachloride	25	0.005	0.005
8 Carbon Disulfide	25	0.005	0.005
9 Chlorobenzene	25	0.005	0.005
10 2-Chloro-1,3-Butadiene	500	0.100	0.100
11 Chlorodibromomethane	25	0.005	0.005
12 Chloroethane	50	0.010	0.010
13 2-Chloroethylvinylether	50	0.010	0.010
14 Chloroform	25	0.005	0.005
15 Chloromethane	50	0.010	0.010
16 3-Chloropropene	500	0.100	0.100
17 1,2-Dibromo-3-Chloropropane	50	0.010	0.010
18 1,2-Dibromoethane	25	0.005	0.005
19 Dibromomethane	25	0.005	0.005
20 Trans-1,4-Dichloro-2-Butene	500	0.100	0.100
21 Dichlorodifluoromethane	50	0.010	0.010
22 1,1-Dichloroethane	25	0.005	0.005
23 1,2-Dichloroethane	25	0.005	0.005
24 1,1-Dichloroethene	25	0.005	0.005
25 Trans-1,2-Dichloroethene	25	0.005	0.005
26 1,2-Dichloropropane	25	0.005	0.005
27 Trans-1,3-Dichloropropene	25	0.005	0.005
28 cis-1,3-Dichloropropene	25	0.005	0.005
29 1,4-Dioxane	1000	0.200	0.200
224 2-Ethoxyethanol	NA	NA	NA
225 Ethyl Acetate	NA	NA	NA
226 Ethylbenzene	25	0.005	0.005
30 Ethyl Cyanide	500	0.100	0.100
227 Ethyl Acetate	NA	NA	NA
31 Ethyl Methacrylate	500	0.100	0.100
214 Ethylene Oxide	NA	NA	NA
32 Iodomethane	250	0.050	0.050
33 Isobutyl Alcohol	1000	0.200	0.200
228 Methanol	NA	NA	NA
Methyl butyl ketone	50	0.010	0.010
34 Methyl ethyl ketone	50	0.010	0.010
229 Methyl isobutyl ketone	50	0.010	0.010
35 Methyl Methacrylate	500	0.100	0.100



TABLE C-4 (Continued)

BOAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Slag) (mg/kg)	Scrubber Wastewater (mg/l)
<u>Volatile Organics (cont.)</u>			
37 Methacrylonitrile	500	0.100	0.100
38 Methylene Chloride	25	0.005	0.005
230 2-Nitropropane	NA	NA	NA
39 Pyridine	2000	0.400	0.400
Styrene	25	0.005	0.005
40 1,1,1,2-Tetrachloroethane	25	0.005	0.005
41 1,1,2,2-Tetrachloroethane	25	0.005	0.005
42 Tetrachloroethene	25	0.005	0.005
43 Toluene	25	0.005	0.005
44 Tribromomethane(bromoform)	25	0.005	0.005
45 1,1,1-Trichloroethane	25	0.005	0.005
46 1,1,2-Trichloroethane	25	0.005	0.005
47 Trichloroethene	25	0.005	0.005
48 Trichloromonofluoromethane	25	0.005	0.005
49 1,2,3-Trichloropropane	25	0.005	0.005
231 1,1,2-Trichloro-1,2,2-trifluoroethane	NA	NA	NA
Vinyl Acetate	50	0.010	0.010
50 Vinyl Chloride	50	0.010	0.010
Xylenes	25	0.005	0.005
<u>Semivolatile Organics</u>			
51 Acenaphthalene	34000	0.420	0.010
52 Acenaphthene	34000	0.420	0.010
53 Acetophenone	68000	0.840	0.020
54 2-Acetylaminofluorene	68000	0.840	0.020
55 4-Aminobiphenyl	68000	0.840	0.020
56 Aniline	34000	0.420	0.010
57 Anthracene	34000	0.420	0.010
58 Aramite	NA	NA	NA
59 Benzo(a)anthracene	34000	0.420	0.010
218 Benzal Chloride	NA	NA	NA
60 Benzenethiol	ND	ND	ND
61 Benzidine	170000	2.1	0.050
Benzoic Acid	172000	2	0.010
62 Benzo(a)pyrene	34000	0.420	0.010
63 Benzo(b)fluoranthene	34000	0.420	0.010
64 Benzo(g,h,i) perylene	34000	0.420	0.010
65 Benzo(k)fluoranthene	34000	0.420	0.010
66 p-Benzoquinone	ND	ND	ND
Benzyl Alcohol	34000	0.420	0.010
67 Bis(2-Chloroethoxy) methane	34000	0.420	0.010
68 Bis(2-Chloroethyl) Ether	34000	0.420	0.010
69 Bis(2-chloroisopropyl) ether	34000	0.420	0.010
70 Bis(2-ethylhexyl) phthalate	34000	0.420	0.010
71 4-Bromophenyl phenyl ether	34000	0.420	0.010

TABLE C-4 (Continued)

BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Slag) (mg/kg)	Scrubber Wastewater (mg/l)
<u>Semivolatile Organics (cont.)</u>			
72 Butyl benzyl phthalate	34000	0.420	0.010
73 2-Sec-Butyl-4,6-Dinitrophenol	170000	2.1	0.050
74 p-Chloroaniline	34000	0.420	0.010
75 Chlorobenzilate	NA	NA	NA
76 p-Chloro-m-cresol	34000	0.420	0.010
77 2-Chloronaphthalene	34000	0.420	0.010
78 2-Chlorophenol	34000	0.420	0.010
4-Chlorophenyl-phenyl ether	34000	0.420	0.010
79 3-Chloropropionitrile	NA	NA	NA
80 Chrysene	34000	0.420	0.010
81 Ortho-cresol	34000	0.420	0.010
82 para-cresol	34000	0.420	0.010
232 Cyclohexanone	ND	ND	ND
83 Dibenz(a,h)anthracene	34000	0.420	0.010
Dibenzofuran	34000	0.420	0.010
84 Dibenzo(a,e,) Pyrene	NA	NA	NA
85 Dibenzo(a,i) Pyrene	NA	NA	NA
86 1,3-Dichlorobenzene	34000	0.420	0.010
87 1,2-Dichlorobenzene	34000	0.420	0.010
88 1,4-Dichlorobenzene	34000	0.420	0.010
89 3,3'-Dichlorobenzidine	68000	0.840	0.020
90 2,4-Dichlorophenol	34000	0.420	0.010
91 2,6-Dichlorophenol	ND	ND	ND
92 Diethyl phthalate	34000	0.420	0.010
93 3,3'-Dimethoxybenzidine	34000	0.420	0.010
94 p-Dimethylaminoazobenzene	68000	0.840	0.020
95 3,3'-Dimethylbenzidine	ND	ND	ND
96 2,4-Dimethylphenol	34000	0.420	0.010
97 Dimethyl Phthalate	34000	0.420	0.010
98 Di-n-butyl phthalate	34000	0.420	0.010
99 1,4-Dinitrobenzene	170000	2.1	0.050
100 4,6-dinitro-o-cresol	172000	2	0.050
101 2,4-Dinitrophenol	172000	2	0.050
102 2,4-Dinitrotoluene	34000	0.420	0.010
103 2,6-Dinitrotoluene	34000	0.420	0.010
104 Di-n-octyl phthalate	34000	0.420	0.010
105 Di-n-propylnitrosoamine	34000	0.420	0.010
106 Diphenylamine (1)	68000	0.840	0.020
107 1,2,-Diphenylhydrazine	170000	2.1	0.050
108 Fluoranthene	34000	0.420	0.010
109 Fluorene	34000	0.420	0.010
110 Hexachlorobenzene	34000	0.420	0.010
111 Hexachlorobutadiene	34000	0.420	0.010
112 Hexachlorocyclopentadiene	34000	0.420	0.010
113 Hexachloroethane	34000	0.420	0.010
114 Hexachlorophene	NA	NA	NA

TABLE C-4 (Continued)

BOAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Slag) (mg/kg)	Scrubber Wastewater (mg/l)
<u>Semivolatile Organics (cont.)</u>			
115 Hexachloropropene	ND	ND	ND
116 Indeno(1,2,3,-cd) Pyrene	34000	0.420	0.010
117 Isosafrole	68000	0.840	0.020
Isophorone	34000	0.420	0.010
118 Methapyrilene	NA	NA	NA
119 3-Methylcholanthrene	68000	0.840	0.020
120 4,4'-Methylene-bis-(2-chloroaniline)	68000	0.840	0.020
36 Methyl Methanesulfonate	ND	ND	ND
2-Methyl naphthalene	34000	0.420	0.010
121 Naphthalene	34000	0.420	0.010
122 1,4-Naphthoquinone	NA	NA	NA
123 1-Naphthylamine	170000	2.1	0.050
124 2-Naphthylamine	170000	2.1	0.050
2-Nitroaniline	172000	2	0.050
3-Nitroaniline	172000	2	0.050
125 p-Nitroaniline	172000	2	0.050
126 Nitrobenzene	34000	0.420	0.010
2-Nitrophenol	34000	0.420	0.010
127 4-Nitrophenol	172000	2	0.050
128 N-Nitrosodi-n-butylamine	ND	ND	ND
129 N-Nitrosodiethylamine	ND	ND	ND
130 N-Nitrosodimethylamine	34000	0.420	0.010
131 N-Nitrosomethylethylamine	34000	0.420	0.010
132 N-Nitrosomorpholine	34000	0.420	0.020
219 N-Nitrosodiphenylamine (1)	68000	0.840	0.010
133 1-Nitrosopiperidine	34000	0.420	0.010
134 N-Nitrosopyrrolidine	170000	2.1	0.050
135 2-Methyl-5-nitroaniline	68000	0.840	0.020
136 Pentachlorobenzene	ND	ND	ND
137 Pentachloroethane	NA	NA	NA
138 Pentachloronitrobenzene	340000	4.2	0.100
139 Pentachlorophenol	172000	2	0.050
140 Phenacetin	68000	0.840	0.020
141 Phenanthrene	34000	0.420	0.010
142 Phenol	34000	0.420	0.010
220 Phthalic Anhydride	ND	ND	ND
143 2-Picoline	34000	0.420	0.010
144 Pronamide	ND	ND	ND
145 Pyrene	34000	0.420	0.010
146 Resorcinol	NA	NA	NA
147 Safrole	170000	2.1	0.050
148 1,2,4,5-Tetrachlorobenzene	68000	0.840	0.020
149 2,3,4,6-Tetrachlorophenol	ND	ND	ND
150 1,2,4-Trichlorobenzene	34000	0.420	0.010
151 2,4,5-Trichlorophenol	172000	2	0.050
152 2,4,6-Trichlorophenol	34000	0.420	0.010
153 Tris(2,3-dibromopropyl) phosphate	ND	ND	ND

TABLE C-4 (Continued)

BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Slag) (mg/kg)	Scrubber Wastewater (mg/l)
<u>Metals - Total Composition</u>			
154 Antimony	3.3	3.3	0.330
155 Arsenic	2.8	100	0.280
156 Barium	0.2	0.2	0.002
157 Beryllium	0.1	0.1	0.001
158 Cadmium	5.0	0.5	0.500
159 Chromium	0.4	0.4	0.004
221 Hexavalent Chromium	0.01	0.01	0.010
160 Copper	0.5	0.5	0.005
161 Lead	0.5	0.5	0.500
162 Mercury	0.02	0.1	0.004
163 Nickel	1.1	1.1	0.011
164 Selenium	0.5	0.5	0.050
165 Silver	0.7	0.7	0.070
166 Thallium	5.0	1.0	0.010
167 Vanadium	0.4	0.4	0.004
168 Zinc	0.4	0.4	0.004
<u>Metals - TCLP (mg/l)</u>			
154 Antimony		0.033	
155 Arsenic		0.100	
156 Barium		0.002	
157 Beryllium	NOT	0.001	NOT
158 Cadmium		0.005	
159 Chromium		0.004	
160 Copper	ANALYZED	0.005	ANALYZED
161 Lead		0.005	
162 Mercury		0.0002	
163 Nickel		0.011	
164 Selenium		0.025	
165 Silver		0.070	
166 Thallium		0.010	
167 Vanadium		0.004	
168 Zinc		0.004	
<u>Inorganics</u>			
169 Cyanide	0.010	0.010	0.010
170 Fluoride	0.2	0.2	0.2
171 Sulfide	0.5	0.5	0.5
<u>Other Parameters</u>			
Chlorides	1	1	1
Sulfates	5	5	5

(1) - Cannot be separated from N-Nitrosodiphenylamine.

NA - The standard is not available; compound was searched using an NBS library of 42,000 compounds.

ND - Not detected, estimated detection limit has not been determined.

TABLE C-5 DETECTION LIMITS FOR K101 SAMPLE SET #4

BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Scrubber Wastewater (mg/l)
<u>Volatile Organics</u>		
222 Acetone	50	0.010
1 Acetonitrile	500	0.100
2 Acrolein	500	0.100
3 Acrylonitrile	500	0.100
4 Benzene	25	0.005
5 Bromodichloromethane	25	0.005
6 Bromomethane	50	0.010
223 n-Butyl Alcohol	NA	NA
7 Carbon Tetrachloride	25	0.005
8 Carbon Disulfide	25	0.005
9 Chlorobenzene	25	0.005
10 2-Chloro-1,3-Butadiene	500	0.100
11 Chlorodibromomethane	25	0.005
12 Chloroethane	50	0.010
13 2-Chloroethylvinylether	50	0.010
14 Chloroform	25	0.005
15 Chloromethane	50	0.010
16 3-Chloropropene	500	0.100
17 1,2-Dibromo-3-Chloropropane	50	0.010
18 1,2-Dibromoethane	25	0.005
19 Dibromomethane	25	0.005
20 Trans-1,4-Dichloro-2-Butene	500	0.100
21 Dichlorodifluoromethane	50	0.010
22 1,1-Dichloroethane	25	0.005
23 1,2-Dichloroethane	25	0.005
24 1,1-Dichloroethene	25	0.005
25 Trans-1,2-Dichloroethene	25	0.005
26 1,2-Dichloropropane	25	0.005
27 Trans-1,3-Dichloropropene	25	0.005
28 cis-1,3-Dichloropropene	25	0.005
29 1,4-Dioxane	1000	0.200
224 2-Ethoxyethanol	NA	NA
225 Ethyl Acetate	NA	NA
226 Ethylbenzene	25	0.005
30 Ethyl Cyanide	500	0.100
227 Ethyl Ether	NA	NA
31 Ethyl Methacrylate	500	0.100
214 Ethylene Oxide	NA	NA
32 Iodomethane	250	0.050
33 Isobutyl Alcohol	1000	0.200
228 Methanol	NA	NA
Methyl butyl ketone	50	0.010
34 Methyl ethyl ketone	50	0.010
229 Methyl isobutyl ketone	50	0.010
35 Methyl Methacrylate	500	0.100

TABLE C-5 (Continued)

BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Scrubber Wastewater (mg/l)
<u>Volatile Organics (cont.)</u>		
37 Methacrylonitrile	500	0.100
38 Methylene Chloride	25	0.005
230 2-Nitropropane	NA	NA
39 Pyridine	2000	0.400
Styrene	25	0.005
40 1,1,1,2-Tetrachloroethane	25	0.005
41 1,1,2,2-Tetrachloroethane	25	0.005
42 Tetrachloroethene	25	0.005
43 Toluene	25	0.005
44 Tribromomethane(bromoform)	25	0.005
45 1,1,1-Trichloroethane	25	0.005
46 1,1,2-Trichloroethane	25	0.005
47 Trichloroethene	25	0.005
48 Trichloromonofluoromethane	25	0.005
49 1,2,3-Trichloropropane	25	0.005
231 1,1,2-Trichloro-1,2,2-trifluoroethane	NA	NA
Vinyl Acetate	50	0.010
50 Vinyl Chloride	50	0.010
Xylenes	25	0.005
<u>Semivolatile Organics</u>		
51 Acenaphthalene	38000	0.010
52 Acenaphthene	38000	0.010
53 Acetophenone	76000	0.020
54 2-Acetylaminofluorene	76000	0.020
55 4-Aminobiphenyl	76000	0.020
56 Aniline	38000	0.010
57 Anthracene	38000	0.010
58 Aramite	NA	NA
59 Benzo(a)anthracene	38000	0.010
218 Benzal Chloride	NA	NA
60 Benzenethiol	ND	ND
61 Benzidine	190000	0.050
Benzoic Acid	190000	0.010
62 Benzo(a)pyrene	38000	0.010
63 Benzo(b)fluoranthene	38000	0.010
64 Benzo(g,h,i) perylene	38000	0.010
65 Benzo(k)fluoranthene	38000	0.010
66 p-Benzoquinone	ND	ND
Benzyl Alcohol	38000	0.010
67 Bis(2-Chloroethoxy) methane	38000	0.010
68 Bis(2-Chloroethyl) Ether	38000	0.010
69 Bis(2-chloroisopropyl) ether	38000	0.010
70 Bis(2-ethylhexyl) phthalate	38000	0.010
71 4-Bromophenyl phenyl ether	38000	0.010

TABLE C-5 (Continued)

BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Scrubber Wastewater (mg/l)
<u>Semivolatile Organics (cont.)</u>		
72 Butyl benzyl phthalate	38000	0.010
73 2-Sec-Butyl-4,6-Dinitrophenol	190000	0.050
74 p-Chloroaniline	38000	0.010
75 Chlorobenzilate	NA	NA
76 p-Chloro-m-cresol	38000	0.010
77 2-Chloronaphthalene	38000	0.010
78 2-Chlorophenol	38000	0.010
4-Chlorophenyl-phenyl ether	38000	0.010
79 3-Chloropropionitrile	NA	NA
80 Chrysene	38000	0.010
81 Ortho-cresol	38000	0.010
82 para-cresol	38000	0.010
232 Cyclohexanone	ND	ND
83 Dibenz(a,h)anthracene	38000	0.010
Dibenzofuran	38000	0.010
84 Dibenzo(a,e,) Pyrene	NA	NA
85 Dibenzo(a,i) Pyrene	NA	NA
86 1,3-Dichlorobenzene	38000	0.010
87 1,2-Dichlorobenzene	38000	0.010
88 1,4-Dichlorobenzene	38000	0.010
89 3,3'-Dichlorobenzidine	76000	0.020
90 2,4-Dichlorophenol	38000	0.010
91 2,6-Dichlorophenol	ND	ND
92 Diethyl phthalate	38000	0.010
93 3,3'-Dimethoxybenzidine	38000	0.010
94 p-Dimethylaminoazobenzene	76000	0.020
95 3,3'-Dimethylbenzidine	ND	ND
96 2,4-Dimethylphenol	38000	0.010
97 Dimethyl Phthalate	38000	0.010
98 Di-n-butyl phthalate	38000	0.010
99 1,4-Dinitrobenzene	190000	0.050
100 4,6-dinitro-o-cresol	190000	0.050
101 2,4-Dinitrophenol	190000	0.050
102 2,4-Dinitrotoluene	38000	0.010
103 2,6-Dinitrotoluene	38000	0.010
104 Di-n-octyl phthalate	38000	0.010
105 Di-n-propylnitrosoamine	38000	0.010
106 Diphenylamine (1)	76000	0.020
107 1,2,-Diphenylhydrazine	190000	0.050
108 Fluoranthene	38000	0.010
109 Fluorene	38000	0.010
110 Hexachlorobenzene	38000	0.010
111 Hexachlorobutadiene	38000	0.010
112 Hexachlorocyclopentadiene	38000	0.010
113 Hexachloroethane	38000	0.010
114 Hexachlorophene	NA	NA

TABLE C-5 (Continued)

BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Scrubber Wastewater (mg/l)
<u>Semivolatiles Organics (cont.)</u>		
115 Hexachloropropene	ND	ND
116 Indeno(1,2,3,-cd) Pyrene	38000	0.010
117 Isosafrole	76000	0.020
Isophorone	38000	0.010
118 Methapyrilene	NA	NA
119 3-Methylcholanthrene	76000	0.020
120 4,4'-Methylene-bis-(2-chloroaniline)	76000	0.020
36 Methyl Methanesulfonate	ND	ND
2-Methyl naphthalene	36000	0.010
121 Naphthalene	36000	0.010
122 1,4-Naphthoquinone	NA	NA
123 1-Naphthylamine	180000	0.050
124 2-Naphthylamine	180000	0.050
2-Nitroaniline	178000	0.050
3-Nitroaniline	178000	0.050
125 p-Nitroaniline	178000	0.050
126 Nitrobenzene	38000	0.010
2-Nitrophenol	38000	0.010
127 4-Nitrophenol	190000	0.050
128 N-Nitrosodi-n-butylamine	ND	ND
129 N-Nitrosodiethylamine	ND	ND
130 N-Nitrosodimethylamine	38000	0.010
131 N-Nitrosomethylethylamine	38000	0.010
132 N-Nitrosomorpholine	38000	0.020
219 N-Nitrosodiphenylamine (1)	76000	0.010
133 1-Nitrosopiperidine	38000	0.010
134 N-Nitrosopyrrolidine	190000	0.050
135 2-Methyl-5-nitroaniline	76000	0.020
136 Pentachlorobenzene	ND	ND
137 Pentachloroethane	NA	NA
138 Pentachloronitrobenzene	380000	0.100
139 Pentachlorophenol	190000	0.050
140 Phenacetin	76000	0.020
141 Phenanthrene	38000	0.010
142 Phenol	38000	0.010
220 Phthalic Anhydride	ND	ND
143 2-Picoline	38000	0.010
144 Pronamide	ND	ND
145 Pyrene	38000	0.010
146 Resorcinol	NA	NA
147 Safrole	190000	0.050
148 1,2,4,5-Tetrachlorobenzene	76000	0.020
149 2,3,4,6-Tetrachlorophenol	ND	ND
150 1,2,4-Trichlorobenzene	38000	0.010
151 2,4,5-Trichlorophenol	190000	0.050
152 2,4,6-Trichlorophenol	38000	0.010
153 Tris(2,3-dibromopropyl) phosphate	ND	ND



TABLE C-5 (Continued)

BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Scrubber Wastewater (mg/l)
<u>Metals - Total Composition</u>		
154 Antimony	3.3	0.330
155 Arsenic	2.8	0.280
156 Barium	0.2	0.002
157 Beryllium	0.1	0.001
158 Cadmium	5.0	0.500
159 Chromium	0.4	0.004
221 Hexavalent Chromium	0.01	0.010
160 Copper	0.5	0.005
161 Lead	1.0	0.500
162 Mercury	0.02	0.0002
163 Nickel	1.1	0.011
164 Selenium	5.0	0.500
165 Silver	0.7	0.070
166 Thallium	5.0	0.010
167 Vanadium	0.4	0.004
168 Zinc	0.4	0.004
<u>Metals - TCLP (mg/l)</u>		
154 Antimony		
155 Arsenic		
156 Barium		
157 Beryllium		
158 Cadmium		
159 Chromium	NOT	NOT
160 Copper		
161 Lead		
162 Mercury	ANALYZED	ANALYZED
163 Nickel		
164 Selenium		
165 Silver		
166 Thallium		
167 Vanadium		
168 Zinc		
<u>Inorganics</u>		
169 Cyanide	-	0.010
170 Flouride	-	0.2
171 Sulfide	-	0.5
<u>Other Parameters</u>		
Chlorides	-	1
Sulfates	-	5

(1) - Cannot be separated from N-Nitrosodiphenylamine.

NA - The standard is not available; compound was searched using an NBS library of 42,000 compounds.

ND - Not detected, estimated detection limit has not been determined.

TABLE C-6 DETECTION LIMITS FOR K102 BACKGROUND WATER, BACKGROUND QUENCH WATER,  
AND FINAL QUENCH WATER

BDAT CONSTITUENT		Background Scrubber Water (mg/l)	Background Quench Water (mg/l)	Final Quench Water (mg/l)
<u>Volatile Organics</u>				
222	Acetone	0.010	0.010	0.010
1	Acetonitrile	0.100	0.100	0.100
2	Acrolein	0.100	0.100	0.100
3	Acrylonitrile	0.100	0.100	0.100
4	Benzene	0.005	0.005	0.005
5	Bromodichloromethane	0.005	0.005	0.005
6	Bromomethane	0.010	0.010	0.010
223	n-Butyl Alcohol	NA	NA	NA
7	Carbon Tetrachloride	0.005	0.005	0.005
8	Carbon Disulfide	0.005	0.005	0.005
9	Chlorobenzene	0.005	0.005	0.005
10	2-Chloro-1,3-Butadiene	0.100	0.100	0.100
11	Chlorodibromomethane	0.005	0.005	0.005
12	Chloroethane	0.010	0.010	0.010
13	2-Chloroethylvinylether	0.010	0.010	0.010
14	Chloroform	0.005	0.005	0.005
15	Chloromethane	0.010	0.010	0.010
16	3-Chloropropene	0.100	0.100	0.100
17	1,2-Dibromo-3-Chloropropane	0.010	0.010	0.010
18	1,2-Dibromoethane	0.005	0.005	0.005
19	Dibromomethane	0.005	0.005	0.005
20	Trans-1,4-Dichloro-2-Butene	0.100	0.100	0.100
21	Dichlorodifluoromethane	0.010	0.010	0.010
22	1,1-Dichloroethane	0.005	0.005	0.005
23	1,2-Dichloroethane	0.005	0.005	0.005
24	1,1-Dichloroethene	0.005	0.005	0.005
25	Trans-1,2-Dichloroethene	0.005	0.005	0.005
26	1,2-Dichloropropane	0.005	0.005	0.005
27	Trans-1,3-Dichloropropene	0.005	0.005	0.005
28	cis-1,3-Dichloropropene	0.005	0.005	0.005
29	1,4-Dioxane	0.200	0.200	0.200
224	2-Ethoxyethanol	NA	NA	NA
225	Ethyl Acetate	NA	NA	NA
226	Ethylbenzene	0.005	0.005	0.005
30	Ethyl Cyanide	0.100	0.100	0.100
227	Ethyl Ether	NA	NA	NA
31	Ethyl Methacrylate	0.100	0.100	0.100
214	Ethylene Oxide	NA	NA	NA
32	Iodomethane	0.050	0.050	0.050
33	Isobutyl Alcohol	0.200	0.200	0.200
228	Methanol	NA	NA	NA
	Methyl butyl ketone	0.010	0.010	0.010
34	Methyl ethyl ketone	0.010	0.010	0.010
229	Methyl isobutyl ketone	0.010	0.010	0.010
35	Methyl Methacrylate	0.100	0.100	0.100

TABLE C-6 (Continued)

BDAT CONSTITUENT	Background	Background	Final
	Scrubber	Quench	Quench
	Water	Water	Water
	(mg/l)	(mg/l)	(mg/l)
<u>Volatile Organics (cont.)</u>			
37 Methacrylonitrile	0.100	0.100	0.100
38 Methylene Chloride	0.005	0.005	0.005
230 2-Nitropropane	NA	NA	NA
39 Pyridine	0.400	0.400	0.400
Styrene	0.005	0.005	0.005
40 1,1,1,2-Tetrachloroethane	0.005	0.005	0.005
41 1,1,2,2-Tetrachloroethane	0.005	0.005	0.005
42 Tetrachloroethene	0.005	0.005	0.005
43 Toluene	0.005	0.005	0.005
44 Tribromomethane(bromoform)	0.005	0.005	0.005
45 1,1,1-Trichloroethane	0.005	0.005	0.005
46 1,1,2-Trichloroethane	0.005	0.005	0.005
47 Trichloroethene	0.005	0.005	0.005
48 Trichloromonofluoromethane	0.005	0.005	0.005
49 1,2,3-Trichloropropane	0.005	0.005	0.005
231 1,1,2-Trichloro-1,2,2-trifluoroethane	NA	NA	NA
Vinyl Acetate	0.010	0.010	0.010
50 Vinyl Chloride	0.010	0.010	0.010
Xylenes	0.005	0.005	0.005
<u>Semivolatile Organics</u>			
51 Acenaphthalene	0.010	0.010	0.010
52 Acenaphthene	0.010	0.010	0.010
53 Acetophenone	0.020	0.020	0.020
54 2-Acetylaminofluorene	0.020	0.020	0.020
55 4-Aminobiphenyl	0.020	0.020	0.020
56 Aniline	0.010	0.010	0.010
57 Anthracene	0.010	0.010	0.010
58 Aramite	NA	NA	NA
59 Benzo(a)anthracene	0.010	0.010	0.010
218 Benzal Chloride	NA	NA	NA
60 Benzenethiol	ND	ND	ND
61 Benzidine	0.050	0.050	0.050
Benzoic Acid	0.010	0.010	0.010
62 Benzo(a)pyrene	0.010	0.010	0.010
63 Benzo(b)fluoranthene	0.010	0.010	0.010
64 Benzo(g,h,i) perylene	0.010	0.010	0.010
65 Benzo(k)fluoranthene	0.010	0.010	0.010
66 p-Benzoquinone	ND	ND	ND
Benzyl Alcohol	0.010	0.010	0.010
67 Bis(2-Chloroethoxy) methane	0.010	0.010	0.010
68 Bis(2-Chloroethyl) Ether	0.010	0.010	0.010
69 Bis(2-chloroisopropyl) ether	0.010	0.010	0.010
70 Bis(2-ethylhexyl) phthalate	0.010	0.010	0.010
71 4-Bromophenyl phenyl ether	0.010	0.010	0.010

TABLE C-6 (Continued)

BDAT CONSTITUENT	Background	Background	Final
	Scrubber Water (mg/l)	Quench Water (mg/l)	Quench Water (mg/l)
<u>Semivolatile Organics (cont.)</u>			
72 Butyl benzyl phthalate	0.010	0.010	0.010
73 2-Sec-Butyl-4,6-Dinitrophenol	0.050	0.050	0.050
74 p-Chloroaniline	0.010	0.010	0.010
75 Chlorobenzilate	NA	NA	NA
76 p-Chloro-m-cresol	0.010	0.010	0.010
77 2-Chloronaphthalene	0.010	0.010	0.010
78 2-Chlorophenol	0.010	0.010	0.010
4-Chlorophenyl-phenyl ether	0.010	0.010	0.010
79 3-Chloropropionitrile	NA	NA	NA
80 Chrysene	0.010	0.010	0.010
81 Ortho-cresol	0.010	0.010	0.010
82 para-cresol	0.010	0.010	0.010
232 Cyclohexanone	ND	ND	ND
83 Dibenz(a,h)anthracene	0.010	0.010	0.010
Dibenzofuran	0.010	0.010	0.010
84 Dibenzo(a,e,) Pyrene	NA	NA	NA
85 Dibenzo(a,i) Pyrene	NA	NA	NA
86 1,3-Dichlorobenzene	0.010	0.010	0.010
87 1,2-Dichlorobenzene	0.010	0.010	0.010
88 1,4-Dichlorobenzene	0.010	0.010	0.010
89 3,3'-Dichlorobenzidine	0.020	0.020	0.020
90 2,4-Dichlorophenol	0.010	0.010	0.010
91 2,6-Dichlorophenol	ND	ND	ND
92 Diethyl phthalate	0.010	0.010	0.010
93 3,3'-Dimethoxybenzidine	0.010	0.010	0.010
94 p-Dimethylaminoazobenzene	0.020	0.020	0.020
95 3,3'-Dimethylbenzidine	ND	ND	ND
96 2,4-Dimethylphenol	0.010	0.010	0.010
97 Dimethyl Phthalate	0.010	0.010	0.010
98 Di-n-butyl phthalate	0.010	0.010	0.010
99 1,4-Dinitrobenzene	0.050	0.050	0.050
100 4,6-dinitro-o-cresol	0.050	0.050	0.050
101 2,4-Dinitrophenol	0.050	0.050	0.050
102 2,4-Dinitrotoluene	0.010	0.010	0.010
103 2,6-Dinitrotoluene	0.010	0.010	0.010
104 Di-n-octyl phthalate	0.010	0.010	0.010
105 Di-n-propylnitrosoamine	0.010	0.010	0.010
106 Diphenylamine (1)	0.020	0.020	0.020
107 1,2,-Diphenylhydrazine	0.050	0.050	0.050
108 Fluoranthene	0.010	0.010	0.010
109 Fluorene	0.010	0.010	0.010
110 Hexachlorobenzene	0.010	0.010	0.010
111 Hexachlorobutadiene	0.010	0.010	0.010
112 Hexachlorocyclopentadiene	0.010	0.010	0.010
113 Hexachloroethane	0.010	0.010	0.010
114 Hexachlorophene	NA	NA	NA

TABLE C-6 (Continued)

BDAT CONSTITUENT	Background	Background	Final
	Scrubber Water (mg/l)	Quench Water (mg/l)	Quench Water (mg/l)
<u>Semivolatile Organics (cont.)</u>			
115 Hexachloropropene	ND	ND	ND
116 Indeno(1,2,3,-cd) Pyrene	0.010	0.010	0.010
117 Isosafrole	0.020	0.020	0.020
Isophorone	0.010	0.010	0.010
118 Methapyrilene	NA	NA	NA
119 3-Methylcholanthrene	0.020	0.020	0.020
120 4,4'-Methylene-bis-(2-chloroaniline)	0.020	0.020	0.020
36 Methyl Methanesulfonate	ND	ND	ND
2-Methyl naphthalene	0.010	0.010	0.010
121 Naphthalene	0.010	0.010	0.010
122 1,4-Naphthoquinone	NA	NA	NA
123 1-Naphthylamine	0.050	0.050	0.050
124 2-Naphthylamine	0.050	0.050	0.050
2-Nitroaniline	0.050	0.050	0.050
3-Nitroaniline	0.050	0.050	0.050
125 p-Nitroaniline	0.050	0.050	0.050
126 Nitrobenzene	0.010	0.010	0.010
2-Nitrophenol	0.010	0.010	0.010
127 4-Nitrophenol	0.050	0.050	0.050
128 N-Nitrosodi-n-butylamine	ND	ND	ND
129 N-Nitrosodiethylamine	ND	ND	ND
130 N-Nitrosodimethylamine	0.010	0.010	0.010
131 N-Nitrosomethylethylamine	0.010	0.010	0.010
132 N-Nitrosomorpholine	0.020	0.020	0.020
219 N-Nitrosodiphenylamine (1)	0.010	0.010	0.010
133 1-Nitrosopiperidine	0.010	0.010	0.010
134 N-Nitrosopyrrolidine	0.050	0.050	0.050
135 2-Methyl-5-nitroaniline	0.020	0.020	0.020
136 Pentachlorobenzene	ND	ND	ND
137 Pentachloroethane	NA	NA	NA
138 Pentachloronitrobenzene	0.100	0.100	0.100
139 Pentachlorophenol	0.050	0.050	0.050
140 Phenacetin	0.020	0.020	0.020
141 Phenanthrene	0.010	0.010	0.010
142 Phenol	0.010	0.010	0.010
220 Phthalic Anhydride	ND	ND	ND
143 2-Picoline	0.010	0.010	0.010
144 Pronamide	ND	ND	ND
145 Pyrene	0.010	0.010	0.010
146 Resorcinol	NA	NA	NA
147 Safrole	0.050	0.050	0.050
148 1,2,4,5-Tetrachlorobenzene	0.020	0.020	0.020
149 2,3,4,6-Tetrachlorophenol	ND	ND	ND
150 1,2,4-Trichlorobenzene	0.010	0.010	0.010
151 2,4,5-Trichlorophenol	0.050	0.050	0.050
152 2,4,6-Trichlorophenol	0.010	0.010	0.010
153 Tris(2,3-dibromopropyl) phosphate	ND	ND	ND

TABLE C-6 (Continued)

BOAT CONSTITUENT	Background	Background	Final
	Scrubber Water (mg/l)	Quench Water (mg/l)	Quench Water (mg/l)
<u>Metals - Total Composition</u>			
154 Antimony	0.015	0.033	0.015
155 Arsenic	0.028	0.028	0.010
156 Barium	0.002	0.002	0.002
157 Beryllium	0.001	0.001	0.001
158 Cadmium	0.005	0.005	0.005
159 Chromium	0.005	0.005	0.005
221 Hexavalent Chromium	0.010	0.010	0.010
160 Copper	0.004	0.004	0.004
161 Lead	0.005	0.005	0.005
162 Mercury	0.004	0.0002	0.0002
163 Nickel	0.009	0.009	0.009
164 Selenium	0.005	0.005	0.005
165 Silver	0.007	0.007	0.007
166 Thallium	0.050	0.010	0.050
167 Vanadium	0.003	0.003	0.003
168 Zinc	0.002	0.002	0.002
<u>Metals - TCLP</u>			
154 Antimony			
155 Arsenic			
156 Barium			
157 Beryllium	NOT		
158 Cadmium			
159 Chromium			
160 Copper		ANALYZED	
161 Lead			
162 Mercury			
163 Nickel			
164 Selenium			
165 Silver			
166 Thallium			
167 Vanadium			
168 Zinc			
<u>Inorganics</u>			
169 Cyanide	0.010	0.010	0.010
170 Flouride	0.2	0.2	0.2
171 Sulfide	0.5	0.9	0.5
<u>Other Parameters</u>			
Chlorides	1	1	1
Sulfates	5	5	5

(1) - Cannot be separated from N-Nitrosodiphenylamine.

NA - The standard is not available; compound was searched using an NBS library of 42,000 compounds.

ND - Not detected, estimated detection limit has not been determined.

TABLE C-7 DETECTION LIMITS FOR FOR K102 SAMPLE SET #1

BDAT CONSTITUENT		Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash) (mg/kg)	Scrubber Wastewater (mg/L)
<u>Volatile Organics (cont.)</u>				
222	Acetone	3	3	0.010
1	Acetonitrile	30	30	0.100
2	Acrolein	30	30	0.100
3	Acrylonitrile	30	30	0.100
4	Benzene	1.5	1.5	0.005
5	Bromodichloromethane	1.5	1.5	0.005
6	Bromomethane	3	3	0.010
223	n-Butyl Alcohol	NA	NA	NA
7	Carbon Tetrachloride	1.5	1.5	0.005
8	Carbon Disulfide	1.5	1.5	0.005
9	Chlorobenzene	1.5	1.5	0.005
10	2-Chloro-1,3-Butadiene	30	30	0.100
11	Chlorodibromomethane	1.5	1.5	0.005
12	Chloroethane	3	3	0.010
13	2-Chloroethylvinylether	3	3	0.010
14	Chloroform	1.5	1.5	0.005
15	Chloromethane	3	3	0.010
16	3-Chloropropene	30	30	0.100
17	1,2-Dibromo-3-Chloropropane	3	3	0.010
18	1,2-Dibromoethane	1.5	1.5	0.005
19	Dibromomethane	1.5	1.5	0.005
20	Trans-1,4-Dichloro-2-Butene	30	30	0.100
21	Dichlorodifluoromethane	3	3	0.010
22	1,1-Dichloroethane	1.5	1.5	0.005
23	1,2-Dichloroethane	1.5	1.5	0.005
24	1,1-Dichloroethene	1.5	1.5	0.005
25	Trans-1,2-Dichloroethene	1.5	1.5	0.005
26	1,2-Dichloropropane	1.5	1.5	0.005
27	Trans-1,3-Dichloropropene	1.5	1.5	0.005
28	cis-1,3-Dichloropropene	1.5	1.5	0.005
29	1,4-Dioxane	60	60	0.200
224	2-Ethoxyethanol	NA	NA	NA
225	Ethyl Acetate	NA	NA	NA
226	Ethylbenzene	1.5	1.5	0.005
30	Ethyl Cyanide	30	30	0.100
227	Ethyl Ether	NA	NA	NA
31	Ethyl Methacrylate	30	30	0.100
214	Ethylene Oxide	NA	NA	NA
32	Iodomethane	15	15	0.050
33	Isobutyl Alcohol	60	60	0.200
228	Methanol	NA	NA	NA
	Methyl butyl ketone	3	3	0.010
34	Methyl ethyl ketone	3	3	0.010
229	Methyl isobutyl ketone	3	3	0.010
35	Methyl Methacrylate	30	30	0.100

TABLE C-7 (Continued)

BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash) (mg/kg)	Scrubber Wastewater (mg/l)
<u>Volatile Organics (cont.)</u>			
37 Methacrylonitrile	30	30	0.100
38 Methylene Chloride	1.5	1.5	0.005
230 2-Nitropropane	NA	NA	NA
39 Pyridine	120	120	0.400
Styrene	1.5	1.5	0.005
40 1,1,1,2-Tetrachloroethane	1.5	1.5	0.005
41 1,1,2,2-Tetrachloroethane	1.5	1.5	0.005
42 Tetrachloroethene	1.5	1.5	0.005
43 Toluene	1.5	1.5	0.005
44 Tribromomethane(bromoform)	1.5	1.5	0.005
45 1,1,1-Trichloroethane	1.5	1.5	0.005
46 1,1,2-Trichloroethane	1.5	1.5	0.005
47 Trichloroethene	1.5	1.5	0.005
48 Trichloromonofluoromethane	1.5	1.5	0.005
49 1,2,3-Trichloropropane	1.5	1.5	0.005
231 1,1,2-Trichloro-1,2,2-trifluoroethane	NA	NA	NA
Vinyl Acetate	3	3	0.010
50 Vinyl Chloride	3	3	0.010
Xylenes	1.5	1.5	0.005
<u>Semivolatile Organics</u>			
51 Acenaphthalene	182	1	0.010
52 Acenaphthene	182	1	0.010
53 Acetophenone	364	2	0.020
54 2-Acetylaminofluorene	364	2	0.020
55 4-Aminobiphenyl	364	2	0.020
56 Aniline	182	1	0.010
57 Anthracene	182	1	0.010
58 Aramite	NA	NA	NA
59 Benzo(a)anthracene	182	1	0.010
218 Benzal Chloride	NA	NA	NA
60 Benzenethiol	ND	ND	ND
61 Benzidine	910	5	0.050
Benzoic Acid	910	5	0.010
62 Benzo(a)pyrene	182	1	0.010
63 Benzo(b)fluoranthene	182	1	0.010
64 Benzo(g,h,i) perylene	182	1	0.010
65 Benzo(k)fluoranthene	182	1	0.010
66 p-Benzoquinone	ND	ND	ND
Benzyl Alcohol	182	1	0.010
67 Bis(2-Chloroethoxy) methane	182	1	0.010
68 Bis(2-Chloroethyl) Ether	182	1	0.010
69 Bis(2-chloroisopropyl) ether	182	1	0.010
70 Bis(2-ethylhexyl) phthalate	182	1	0.010
71 4-Bromophenyl phenyl ether	182	1	0.010



TABLE C-7 (Continued)

BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash) (mg/kg)	Scrubber Wastewater (mg/l)
<u>Semivolatile Organics (cont.)</u>			
72 Butyl benzyl phthalate	182	1	0.010
73 2-Sec-Butyl-4,6-Dinitrophenol	910	5	0.050
74 p-Chloroaniline	182	1	0.010
75 Chlorobenzilate	NA	NA	NA
76 p-Chloro-m-cresol	182	1	0.010
77 2-Chloronaphthalene	182	1	0.010
78 2-Chlorophenol	182	1	0.010
4-Chlorophenyl-phenyl ether	182	1	0.010
79 3-Chloropropionitrile	NA	NA	NA
80 Chrysene	182	1	0.010
81 Ortho-cresol	182	1	0.010
82 para-cresol	182	1	0.010
232 Cyclohexanone	ND	ND	ND
83 Dibenz(a,h)anthracene	182	1	0.010
Dibenzofuran	182	1	0.010
84 Dibenzo(a,e,) Pyrene	NA	NA	NA
85 Dibenzo(a,i) Pyrene	NA	NA	NA
86 1,3-Dichlorobenzene	182	1	0.010
87 1,2-Dichlorobenzene	182	1	0.010
88 1,4-Dichlorobenzene	182	1	0.010
89 3,3'-Dichlorobenzidine	364	2	0.020
90 2,4-Dichlorophenol	182	1	0.010
91 2,6-Dichlorophenol	ND	ND	ND
92 Diethyl phthalate	182	1	0.010
93 3,3'-Dimethoxybenzidine	182	1	0.010
94 p-Dimethylaminoazobenzene	364	2	0.020
95 3,3'-Dimethylbenzidine	ND	ND	ND
96 2,4-Dimethylphenol	182	1	0.010
97 Dimethyl Phthalate	182	1	0.010
98 Di-n-butyl phthalate	182	1	0.010
99 1,4-Dinitrobenzene	910	5	0.050
100 4,6-dinitro-o-cresol	910	5	0.050
101 2,4-Dinitrophenol	910	5	0.050
102 2,4-Dinitrotoluene	182	1	0.010
103 2,6-Dinitrotoluene	182	1	0.010
104 Di-n-octyl phthalate	182	1	0.010
105 Di-n-propylnitrosoamine	182	1	0.010
106 Diphenylamine (1)	364	2	0.020
107 1,2,-Diphenylhydrazine	910	5	0.050
108 Fluoranthene	182	1	0.010
109 Fluorene	182	1	0.010
110 Hexachlorobenzene	182	1	0.010
111 Hexachlorobutadiene	182	1	0.010
112 Hexachlorocyclopentadiene	182	1	0.010
113 Hexachloroethane	182	1	0.010
114 Hexachlorophene	NA	NA	NA

TABLE C-7 (Continued)

BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash) (mg/kg)	Scrubber Wastewater (mg/l)
<u>Semivolatile Organics (cont.)</u>			
115 Hexachloropropene	ND	ND	ND
116 Indeno(1,2,3,-cd) Pyrene	182	1	0.010
117 Isosafrole	364	2	0.020
Isophorone	182	1	0.010
118 Methapyrilene	NA	NA	NA
119 3-Methylcholanthrene	364	2	0.020
120 4,4'-Methylene-bis-(2-chloroaniline)	364	2	0.020
36 Methyl Methanesulfonate	ND	ND	ND
2-Methylnaphthalene	182	1	0.010
121 Naphthalene	182	1	0.010
122 1,4-Naphthoquinone	NA	NA	NA
123 1-Naphthylamine	910	5	0.050
124 2-Naphthylamine	910	5	0.050
2-Nitroaniline	910	5	0.050
3-Nitroaniline	910	5	0.050
125 p-Nitroaniline	910	5	0.050
126 Nitrobenzene	182	1	0.010
2-Nitrophenol	182	1	0.010
127 4-Nitrophenol	910	5	0.050
128 N-Nitrosodi-n-butylamine	ND	ND	ND
129 N-Nitrosodiethylamine	ND	ND	ND
130 N-Nitrosodimethylamine	182	1	0.010
219 N-Nitrosodiphenylamine (1)	182	1	0.010
131 N-Nitrosomethylethylamine	182	1	0.020
132 N-Nitrosomorpholine	364	2	0.010
133 1-Nitrosopiperidine	182	1	0.010
134 N-Nitrosopyrrolidine	910	5	0.050
135 2-Methyl-5-nitroaniline	364	2	0.020
136 Pentachlorobenzene	ND	ND	ND
137 Pentachloroethane	NA	NA	NA
138 Pentachloronitrobenzene	1820	1	0.100
139 Pentachlorophenol	910	5	0.050
140 Phenacetin	364	2	0.020
141 Phenanthrene	182	1	0.010
142 Phenol	182	1	0.010
220 Phthalic Anhydride	ND	ND	ND
143 2-Picoline	182	1	0.010
144 Pronamide	ND	ND	ND
145 Pyrene	182	1	0.010
146 Resorcinol	NA	NA	NA
147 Safrole	910	5	0.050
148 1,2,4,5-Tetrachlorobenzene	364	2	0.020
149 2,3,4,6-Tetrachlorophenol	ND	ND	ND
150 1,2,4-Trichlorobenzene	182	1	0.010
151 2,4,5-Trichlorophenol	910	5	0.050
152 2,4,6-Trichlorophenol	182	1	0.010
153 Tris(2,3-dibromopropyl) phosphate	ND	ND	ND

TABLE C-7 (Continued)

BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash) (mg/kg)	Scrubber Wastewater (mg/l)
<u>Metals - Total Composition</u>			
154 Antimony	1.5	1.5	0.015
155 Arsenic	1.0	1.0	0.010
156 Barium	0.2	0.2	0.002
157 Beryllium	0.1	0.1	0.010
158 Cadmium	0.5	0.5	0.005
159 Chromium	0.5	0.5	0.005
Hexavalent Chromium (mg/l)	0.01	0.01	0.010
160 Copper	0.4	0.4	0.004
161 Lead	0.5	0.5	0.005
162 Mercury	0.1	0.1	0.0002
163 Nickel	0.9	0.9	0.220
164 Selenium	0.5	0.5	0.005
165 Silver	0.7	0.7	0.005
166 Thallium	1.0	5.0	0.010
167 Vanadium	0.4	0.3	0.003
168 Zinc	0.2	0.2	0.002
<u>Metals - TCLP (mg/l)</u>			
154 Antimony		0.015	
155 Arsenic		0.010	
156 Barium		0.002	
157 Beryllium	NOT	0.001	NOT
158 Cadmium		0.005	
159 Chromium		0.005	
160 Copper	ANALYZED	0.004	ANALYZED
161 Lead		0.005	
162 Mercury		0.0002	
163 Nickel		0.009	
164 Selenium		0.050	
165 Silver		0.007	
166 Thallium		0.500	
167 Vanadium		0.004	
168 Zinc		0.002	
<u>Inorganics</u>			
169 Cyanide	-	-	0.010
170 Fluoride	-	-	0.2
171 Sulfide	-	-	0.5
<u>Other Parameters</u>			
Chlorides	-	-	1
Sulfates	-	-	5

(1) - Cannot be separated from N-Nitrosodiphenylamine.

NA - The standard is not available; compound was searched using an NBS library of 42,000 compounds.

ND - Not detected, estimated detection limit has not been determined.

- - No detection limit established.

TABLE C-8 DETECTION LIMITS FOR K102 SAMPLE SETS #2 AND #3

BDAT CONSTITUENT		Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash) (mg/kg)	Scrubber Wastewater (mg/l)
<u>Volatile Organics</u>				
222	Acetone	3	3	0.010
1	Acetonitrile	30	30	0.100
2	Acrolein	30	30	0.100
3	Acrylonitrile	30	30	0.100
4	Benzene	1.5	1.5	0.005
5	Bromodichloromethane	1.5	1.5	0.005
6	Bromomethane	3	3	0.010
223	n-Butyl Alcohol	NA	NA	NA
7	Carbon Tetrachloride	1.5	1.5	0.005
8	Carbon Disulfide	1.5	1.5	0.005
9	Chlorobenzene	1.5	1.5	0.005
10	2-Chloro-1,3-Butadiene	30	30	0.100
11	Chlorodibromomethane	1.5	1.5	0.005
12	Chloroethane	3	3	0.010
13	2-Chloroethylvinylether	3	3	0.010
14	Chloroform	1.5	1.5	0.005
15	Chloromethane	3	3	0.010
16	3-Chloropropene	30	30	0.100
17	1,2-Dibromo-3-Chloropropane	3	3	0.010
18	1,2-Dibromoethane	1.5	1.5	0.005
19	Dibromomethane	1.5	1.5	0.005
20	Trans-1,4-Dichloro-2-Butene	30	30	0.100
21	Dichlorodifluoromethane	3	3	0.010
22	1,1-Dichloroethane	1.5	1.5	0.005
23	1,2-Dichloroethane	1.5	1.5	0.005
24	1,1-Dichloroethene	1.5	1.5	0.005
25	Trans-1,2-Dichloroethene	1.5	1.5	0.005
26	1,2-Dichloropropane	1.5	1.5	0.005
27	Trans-1,3-Dichloropropene	1.5	1.5	0.005
28	cis-1,3-Dichloropropene	1.5	1.5	0.005
29	1,4-Dioxane	60	60	0.200
224	2-Ethoxyethanol	NA	NA	NA
225	Ethyl Acetate	NA	NA	NA
226	Ethylbenzene	1.5	1.5	0.005
30	Ethyl Cyanide	30	30	0.100
227	Ethyl Ether	NA	NA	NA
31	Ethyl Methacrylate	30	30	0.100
214	Ethylene Oxide	NA	NA	NA
32	Iodomethane	15	15	0.050
33	Isobutyl Alcohol	60	60	0.200
228	Methanol	NA	NA	NA
	Methyl butyl ketone	3	3	0.010
34	Methyl ethyl ketone	3	3	0.010
229	Methyl isobutyl ketone	3	3	0.010
35	Methyl Methacrylate	30	30	0.100

TABLE C-8 (Continued)

BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash) (mg/kg)	Scrubber Wastewater (mg/l)
<u>Volatile Organics (cont.)</u>			
37 Methacrylonitrile	30	30	0.100
38 Methylene Chloride	1.5	1.5	0.005
230 2-Nitropropane	NA	NA	NA
39 Pyridine	120	120	0.400
Styrene	1.5	1.5	0.005
40 1,1,1,2-Tetrachloroethane	1.5	1.5	0.005
41 1,1,2,2-Tetrachloroethane	1.5	1.5	0.005
42 Tetrachloroethene	1.5	1.5	0.005
43 Toluene	1.5	1.5	0.005
44 Tribromomethane(bromoform)	1.5	1.5	0.005
45 1,1,1-Trichloroethane	1.5	1.5	0.005
46 1,1,2-Trichloroethane	1.5	1.5	0.005
47 Trichloroethene	1.5	1.5	0.005
48 Trichloromonofluoromethane	1.5	1.5	0.005
49 1,2,3-Trichloropropane	1.5	1.5	0.005
231 1,1,2-Trichloro-1,2,2-trifluoroethane	NA	NA	NA
Vinyl Acetate	3	3	0.010
50 Vinyl Chloride	3	3	0.010
Xylenes	1.5	1.5	0.005
<u>Semivolatile Organics</u>			
51 Acenaphthalene	19.4	1	0.010
52 Acenaphthene	19.4	1	0.010
53 Acetophenone	38.8	2	0.020
54 2-Acetylaminofluorene	38.8	2	0.020
55 4-Aminobiphenyl	38.8	2	0.020
56 Aniline	19.4	1	0.010
57 Anthracene	19.4	1	0.010
58 Aramite	NA	NA	NA
59 Benzo(a)anthracene	19.4	1	0.010
218 Benzal Chloride	NA	NA	NA
60 Benzenethiol	ND	ND	ND
61 Benzidine	97	5	0.050
Benzoic Acid	98	5	0.010
62 Benzo(a)pyrene	19.4	1	0.010
63 Benzo(b)fluoranthene	19.4	1	0.010
64 Benzo(g,h,i) perylene	19.4	1	0.010
65 Benzo(k)fluoranthene	19.4	1	0.010
66 p-Benzoquinone*SP	ND	ND	ND
Benzyl Alcohol	19.4	1	0.010
67 Bis(2-Chloroethoxy) methane	19.4	1	0.010
68 Bis(2-Chloroethyl) Ether	19.4	1	0.010
69 Bis(2-chloroisopropyl) ether	19.4	1	0.010
70 Bis(2-ethylhexyl) phthalate	19.4	1	0.010
71 4-Bromophenyl phenyl ether	19.4	1	0.010

TABLE C-8 (Continued)

BOAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash) (mg/kg)	Scrubber Wastewater (mg/l)
<u>Semivolatile Organics (cont.)</u>			
72 Butyl benzyl phthalate	19.4	1	0.010
73 2-Sec-Butyl-4,6-Dinitrophenol	97	5	0.050
74 p-Chloroaniline	19.4	1	0.010
75 Chlorobenzilate	NA	NA	NA
76 p-Chloro-m-cresol	19.4	1	0.010
77 2-Chloronaphthalene	19.4	1	0.010
78 2-Chlorophenol	19.4	1	0.010
4-Chlorophenyl-phenyl ether	19.4	1	0.010
79 3-Chloropropionitrile	NA	NA	NA
80 Chrysene	19.4	1	0.010
81 Ortho-cresol	19.4	1	0.010
82 para-cresol	19.4	1	0.010
232 Cyclohexanone	ND	ND	ND
83 Dibenz(a,h)anthracene	19.4	1	0.010
Dibenzofuran	19.4	1	0.010
84 Dibenzo(a,e,) Pyrene	NA	NA	NA
85 Dibenzo(a,i) Pyrene	NA	NA	NA
86 1,3-Dichlorobenzene	19.4	1	0.010
87 1,2-Dichlorobenzene	19.4	1	0.010
88 1,4-Dichlorobenzene	19.4	1	0.010
89 3,3'-Dichlorobenzidine	38	2	0.020
90 2,4-Dichlorophenol	19.4	1	0.010
91 2,6-Dichlorophenol	ND	ND	ND
92 Diethyl phthalate	19.4	1	0.010
93 3,3'-Dimethoxybenzidine	19.4	1	0.010
94 p-Dimethylaminoazobenzene	38.8	2	0.020
95 3,3'-Dimethylbenzidine	ND	ND	ND
96 2,4-Dimethylphenol	19.4	1	0.010
97 Dimethyl Phthalate	19.4	1	0.010
98 Di-n-butyl phthalate	19.4	1	0.010
99 1,4-Dinitrobenzene	97	5	0.050
100 4,6-dinitro-o-cresol	98	5	0.050
101 2,4-Dinitrophenol	98	5	0.050
102 2,4-Dinitrotoluene	19.4	1	0.010
103 2,6-Dinitrotoluene	19.4	1	0.010
104 Di-n-octyl phthalate	19.4	1	0.010
105 Di-n-propylnitrosoamine	19.4	1	0.010
106 Diphenylamine (1)	38.8	2	0.020
107 1,2,-Diphenylhydrazine	97	5	0.050
108 Fluoranthene	19.4	1	0.010
109 Fluorene	19.4	1	0.010
110 Hexachlorobenzene	19.4	1	0.010
111 Hexachlorobutadiene	19.4	1	0.010
112 Hexachlorocyclopentadiene	19.4	1	0.010
113 Hexachloroethane	19.4	1	0.010
114 Hexachlorophene	NA	NA	NA

TABLE C-8 (Continued)

BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash) (mg/kg)	Scrubber Wastewater (mg/l)
<u>Semivolatile Organics (cont.)</u>			
115 Hexachloropropene	ND	ND	ND
116 Indeno(1,2,3,-cd) Pyrene	19.4	1	0.010
117 Isosafrole	38.8	2	0.010
Isophorone	19.4	1	0.020
118 Methapyrilene	NA	NA	NA
119 3-Methylcholanthrene	38.8	2	0.020
120 4,4'-Methylene-bis-(2-chloroaniline)	38.8	2	0.020
36 Methyl Methanesulfonate	ND	ND	ND
2-Methylnaphthalene	19.4	1	0.010
121 Naphthalene	19.4	1	0.010
122 1,4-Naphthoquinone	NA	NA	NA
123 1-Naphthylamine	97	5	0.050
124 2-Naphthylamine	97	5	0.050
2-Nitroaniline	98	5	0.050
3-Nitroaniline	98	5	0.050
125 p-Nitroaniline	98	5	0.050
126 Nitrobenzene	19.4	1	0.010
2-Nitrophenol	19.4	1	0.010
127 4-Nitrophenol	98	5	0.050
128 N-Nitrosodi-n-butylamine	ND	ND	ND
129 N-Nitrosodiethylamine	ND	ND	ND
130 N-Nitrosodimethylamine	19.4	1	0.010
219 N-Nitrosodiphenylamine (1)	19.4	1	0.010
131 N-Nitrosomethylethylamine	19.4	1	0.020
132 N-Nitrosomorpholine	38.8	2	0.010
133 1-Nitrosopiperidine	19.4	1	0.010
134 N-Nitrosopyrrolidine	97	5	0.050
135 2-Methyl-5-nitroaniline	38.8	2	0.020
136 Pentachlorobenzene	ND	ND	ND
137 Pentachloroethane	NA	NA	NA
138 Pentachloronitrobenzene	194	1	0.100
139 Pentachlorophenol	98	5	0.050
140 Phenacetin	38.8	2	0.020
141 Phenanthrene	19.4	1	0.010
142 Phenol	19.4	1	0.010
220 Phthalic Anhydride	ND	ND	ND
143 2-Picoline	19.4	1	0.010
144 Pronamide	ND	ND	ND
145 Pyrene	19.4	1	0.010
146 Resorcinol	NA	NA	NA
147 Safrole	97	5	0.050
148 1,2,4,5-Tetrachlorobenzene	38.8	2	0.020
149 2,3,4,6-Tetrachlorophenol	ND	ND	ND
150 1,2,4-Trichlorobenzene	19.4	1	0.010
151 2,4,5-Trichlorophenol	98	5	0.050
152 2,4,6-Trichlorophenol	19.4	1	0.010
153 Tris(2,3-dibromopropyl) phosphate	ND	ND	ND

TABLE C-8 (Continued)

BDAT CONSTITUENT		Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash) (mg/kg)	Scrubber Wastewater (mg/l)
<u>Metals - Total Composition</u>				
154	Antimony	1.5	1.5	0.015
155	Arsenic	1.0	1.0	0.010
156	Barium	0.2	0.2	0.002
157	Beryllium	0.1	0.1	0.001
158	Cadmium	0.5	0.5	0.005
159	Chromium	0.5	0.5	0.005
221	Hexavalent Chromium (mg/l)	0.01	0.01	0.010
160	Copper	0.4	0.4	0.004
161	Lead	0.5	0.5	0.005
162	Mercury	0.1	0.1	0.0002
163	Nickel	0.9	0.9	0.220**
164	Selenium	0.5	0.5	0.005
165	Silver	0.7	0.7	0.005
166	Thallium	1.0	1.0	0.010
167	Vanadium	0.4	0.4	0.003
168	Zinc	0.2	0.2	0.002
<u>Metals - TCLP (mg/l)</u>				
154	Antimony		0.015	
155	Arsenic		0.010	
156	Barium		0.002	
157	Beryllium	NOT	0.001	NOT
158	Cadmium		0.005	
159	Chromium		0.007+	
160	Copper	ANALYZED	0.004	ANALYZED
161	Lead		0.005	
162	Mercury		0.0002+	
163	Nickel		0.009	
164	Selenium		0.005	
165	Silver		0.007+	
166	Thallium		0.200+	
167	Vanadium		0.004+	
168	Zinc		0.002	



TABLE C-8 (Continued)

BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash) (mg/kg)	Scrubber Wastewater (mg/l)
<u>Inorganics</u>			
169 Cyanide	-	-	0.01
170 Flouride	-	-	0.2
171 Sulfide	-	-	0.5
<u>Other Parameters</u>			
Chlorides	-	-	1
Sulfates	-	-	5

(1) - Cannot be separated from N-Nitrosodiphenylamine.

NA - The standard is not available; compound was searched using an NBS library of 42,000 compounds.

ND - Not detected, estimated detection limit has not been determined.

\*\* - Detection limit for sample set 3 for Nickel is 0.110 mg/l.

+ - Detection limits for sample set 3 for Chromium, Mercury, Silver, and Vanadium were 0.007, 0.0004, 0.006, 0.010, and 0.006 mg/l, respectively.

- - No detection limits have been established.

TABLE C-9 DETECTION LIMITS FOR K102 SAMPLE SETS #4 AND #5

BDAT CONSTITUENT		Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash)* (mg/kg)	Scrubber Wastewater (mg/l)
<u>Volatile Organics</u>				
222	Acetone	3	3	0.010
1	Acetonitrile	30	30	0.100
2	Acrolein	30	30	0.100
3	Acrylonitrile	30	30	0.100
4	Benzene	1.5	1.5	0.005
5	Bromodichloromethane	1.5	1.5	0.005
6	Bromomethane	3	3	0.010
223	n-Butyl Alcohol	NA	NA	NA
7	Carbon Tetrachloride	1.5	1.5	0.005
8	Carbon Disulfide	1.5	1.5	0.005
9	Chlorobenzene	1.5	1.5	0.005
10	2-Chloro-1,3-Butadiene	30	30	0.100
11	Chlorodibromomethane	1.5	1.5	0.005
12	Chloroethane	3	3	0.010
13	2-Chloroethylvinylether	3	3	0.010
14	Chloroform	1.5	1.5	0.005
15	Chloromethane	3	3	0.010
16	3-Chloropropene	30	30	0.100
17	1,2-Dibromo-3-Chloropropane	3	3	0.010
18	1,2-Dibromoethane	1.5	1.5	0.005
19	Dibromomethane	1.5	1.5	0.005
20	Trans-1,4-Dichloro-2-Butene	30	30	0.100
21	Dichlorodifluoromethane	3	3	0.010
22	1,1-Dichloroethane	1.5	1.5	0.005
23	1,2-Dichloroethane	1.5	1.5	0.005
24	1,1-Dichloroethene	1.5	1.5	0.005
25	Trans-1,2-Dichloroethene	1.5	1.5	0.005
26	1,2-Dichloropropane	1.5	1.5	0.005
27	Trans-1,3-Dichloropropene	1.5	1.5	0.005
28	cis-1,3-Dichloropropene	1.5	1.5	0.005
29	1,4-Dioxane	60	60	0.200
224	2-Ethoxyethanol	NA	NA	NA
225	Ethyl Acetate	NA	NA	NA
226	Ethylbenzene	1.5	1.5	0.005
30	Ethyl Cyanide	30	30	0.100
227	Ethyl Ether	NA	NA	NA
31	Ethyl Methacrylate	30	30	0.100
214	Ethylene Oxide	NA	NA	NA
32	Iodomethane	15	15	0.050
33	Isobutyl Alcohol	60	60	0.200
228	Methanol	NA	NA	NA
	Methyl butyl ketone	3	3	0.010
34	Methyl ethyl ketone	3	3	0.010
229	Methyl isobutyl ketone	3	3	0.010
35	Methyl Methacrylate	30	30	0.100

TABLE C-9 (Continued)

BOAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash)* (mg/kg)	Scrubber Wastewater (mg/l)
<u>Volatile Organics (cont.)</u>			
37 Methacrylonitrile	30	30	0.100
38 Methylene Chloride	1.5	1.5	0.005
230 2-Nitropropane	NA	NA	NA
39 Pyridine	120	120	0.400
Styrene	1.5	1.5	0.005
40 1,1,1,2-Tetrachloroethane	1.5	1.5	0.005
41 1,1,2,2-Tetrachloroethane	1.5	1.5	0.005
42 Tetrachloroethene	1.5	1.5	0.005
43 Toluene	1.5	1.5	0.005
44 Tribromomethane(bromoform)	1.5	1.5	0.005
45 1,1,1-Trichloroethane	1.5	1.5	0.005
46 1,1,2-Trichloroethane	1.5	1.5	0.005
47 Trichloroethene	1.5	1.5	0.005
48 Trichloromonofluoromethane	1.5	1.5	0.005
49 1,2,3-Trichloropropane	1.5	1.5	0.005
231 1,1,2-Trichloro-1,2,2-trifluoroethane	NA	NA	NA
Vinyl Acetate	3	3	0.010
50 Vinyl Chloride	3	3	0.010
Xylene <sup>2</sup>	1.5	1.5	0.005
<u>Semivolatile Organics</u>			
51 Acenaphthalene	194	1	0.010
52 Acenaphthene	194	1	0.010
53 Acetophenone	388	2	0.020
54 2-Acetylaminofluorene	388	2	0.020
55 4-Aminobiphenyl	388	2	0.020
56 Aniline	194	1	0.010
57 Anthracene	194	1	0.010
58 Aramite	NA	NA	NA
59 Benzo(a)anthracene	194	1	0.010
218 Benzal Chloride	NA	NA	NA
60 Benzenethiol	ND	ND	ND
61 Benzidine	970	5	0.050
Benzoic Acid	980	5	0.010
62 Benzo(a)pyrene	194	1	0.010
63 Benzo(b)fluoranthene	194	1	0.010
64 Benzo(g,h,i) perylene	194	1	0.010
65 Benzo(k)fluoranthene	194	1	0.010
66 p-Benzoquinone	ND	ND	ND
Benzyl Alcohol	194	1	0.010
67 Bis(2-Chloroethoxy) methane	194	1	0.010
68 Bis(2-Chloroethyl) Ether	194	1	0.010
69 Bis(2-chloroisopropyl) ether	194	1	0.010
70 Bis(2-ethylhexyl) phthalate	194	1	0.010
71 4-Bromophenyl phenyl ether	194	1	0.010

TABLE C-9 (Continued)

BOAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash)* (mg/kg)	Scrubber Wastewater (mg/l)
<u>Semivolatile Organics (cont.)</u>			
72 Butyl benzyl phthalate	194	1	0.010
73 2-Sec-Butyl-4,6-Dinitrophenol	970	5	0.050
74 p-Chloroaniline	194	1	0.010
75 Chlorobenzilate	NA	NA	NA
76 p-Chloro-m-cresol	194	1	0.010
77 2-Chloronaphthalene	194	1	0.010
78 2-Chlorophenol	194	1	0.010
4-Chlorophenyl-phenyl ether	194	1	0.010
79 3-Chloropropionitrile	NA	NA	NA
80 Chrysene	194	1	0.010
81 Ortho-cresol	194	1	0.010
82 para-cresol	194	1	0.010
232 Cyclohexanone	ND	ND	ND
83 Dibenz(a,h)anthracene	194	1	0.010
Dibenzofuran	194	1	0.010
84 Dibenzo(a,e,) Pyrene	NA	NA	NA
85 Dibenzo(a,i) Pyrene	NA	NA	NA
86 1,3-Dichlorobenzene	194	1	0.010
87 1,2-Dichlorobenzene	194	1	0.010
88 1,4-Dichlorobenzene	194	1	0.010
89 3,3'-Dichlorobenzidine	380	2	0.020
90 2,4-Dichlorophenol	194	1	0.010
91 2,6-Dichlorophenol	ND	ND	ND
92 Diethyl phthalate	194	1	0.010
93 3,3'-Dimethoxybenzidine	194	1	0.010
94 p-Dimethylaminoazobenzene	388	2	0.020
95 3,3'-Dimethylbenzidine	ND	ND	ND
96 2,4-Dimethylphenol	194	1	0.010
97 Dimethyl Phthalate	194	1	0.010
98 Di-n-butyl phthalate	194	1	0.010
99 1,4-Dinitrobenzene	970	5	0.050
100 4,6-dinitro-o-cresol	980	5	0.050
101 2,4-Dinitrophenol	980	5	0.050
102 2,4-Dinitrotoluene	194	1	0.010
103 2,6-Dinitrotoluene	194	1	0.010
104 Di-n-octyl phthalate	194	1	0.010
105 Di-n-propylnitrosoamine	194	1	0.010
106 Diphenylamine (1)	388	2	0.020
107 1,2,-Diphenylhydrazine	970	5	0.050
108 Fluoranthene	194	1	0.010
109 Fluorene	194	1	0.010
110 Hexachlorobenzene	194	1	0.010
111 Hexachlorobutadiene	194	1	0.010
112 Hexachlorocyclopentadiene	194	1	0.010
113 Hexachloroethane	194	1	0.010
114 Hexachlorophene	NA	NA	NA

TABLE C-9 (Continued)

BOAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash)* (mg/kg)	Scrubber Wastewater (mg/l)
<u>Semivolatile Organics (cont.)</u>			
115 Hexachloropropene	ND	ND	ND
116 Indeno(1,2,3,-cd) Pyrene	194	1	0.010
117 Isosafrole	388	2	0.020
Isophorone	194	1	0.010
118 Methapyrilene	NA	NA	NA
119 3-Methylcholanthrene	388	2	0.020
120 4,4'-Methylene-bis-(2-chloroaniline)	388	2	0.020
36 Methyl Methanesulfonate	ND	ND	ND
2-Methylnaphthalene	194	1	0.010
121 Naphthalene	194	1	0.010
122 1,4-Naphthoquinone	NA	NA	NA
123 1-Naphthylamine	970	5	0.050
124 2-Naphthylamine	970	5	0.050
2-Nitroaniline	980	5	0.050
3-Nitroaniline	980	5	0.050
125 p-Nitroaniline	980	5	0.050
126 Nitrobenzene	194	1	0.010
2-Nitrophenol	194	1	0.010
127 4-Nitrophenol	980	5	0.050
128 N-Nitrosodi-n-butylamine	ND	ND	ND
129 N-Nitrosodiethylamine	ND	ND	ND
130 N-Nitrosodimethylamine	194	1	0.010
219 N-Nitrosodiphenylamine (1)	194	1	0.010
131 N-Nitrosomethylethylamine	194	1	0.020
132 N-Nitrosomorpholine	388	2	0.010
133 1-Nitrosopiperidine	194	1	0.010
134 N-Nitrosopyrrolidine	970	5	0.050
135 2-Methyl-5-nitroaniline	388	2	0.020
136 Pentachlorobenzene	ND	ND	ND
137 Pentachloroethane	NA	NA	NA
138 Pentachloronitrobenzene	1940	1	0.100
139 Pentachlorophenol	980	5	0.050
140 Phenacetin	388	2	0.020
141 Phenanthrene	194	1	0.010
142 Phenol	194	1	0.010
220 Phthalic Anhydride	ND	ND	ND
143 2-Picoline	194	1	0.010
144 Pronamide	ND	ND	ND
145 Pyrene	194	1	0.010
146 Resorcinol	NA	NA	NA
147 Safrole	970	5	0.050
148 1,2,4,5-Tetrachlorobenzene	388	2	0.020
149 2,3,4,6-Tetrachlorophenol	ND	ND	ND
150 1,2,4-Trichlorobenzene	194	1	0.010
151 2,4,5-Trichlorophenol	980	5	0.050
152 2,4,6-Trichlorophenol	194	1	0.010
153 Tris(2,3-dibromopropyl) phosphate	ND	ND	ND

TABLE C-9 (Continued)

BOAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash)* (mg/kg)	Scrubber Wastewater (mg/l)
<u>Metals - Total Composition</u>			
154 Antimony	1.5	1.5	0.015
155 Arsenic	1.0	1.0	0.010
156 Barium	0.2	0.2	0.002
157 Beryllium	0.1	0.10	0.001
158 Cadmium	0.5	0.5	0.005
159 Chromium	0.5	0.5	0.005
221 Hexavalent Chromium (mg/L)	0.01	0.01	0.010
160 Copper	0.4	0.4	0.004
161 Lead	0.5	0.5	0.005
162 Mercury	0.1	0.1	0.0002
163 Nickel	1.1+	0.9	0.009
164 Selenium	0.5	0.5	0.005
165 Silver	0.7	0.7	0.005
166 Thallium	1.0	1.0	0.010
167 Vanadium	0.4	0.3	0.003
168 Zinc	0.2	0.2	0.002
<u>Metals - TCLP (mg/L)</u>			
154 Antimony		0.015	
155 Arsenic		0.010	
156 Barium		0.002	
157 Beryllium	NOT	0.001	NOT
158 Cadmium		0.005	
159 Chromium		0.005	
160 Copper	ANALYZED	0.004	ANALYZED
161 Lead		0.005	
162 Mercury		0.0002	
163 Nickel		0.009	
164 Selenium		0.005	
165 Silver		0.007	
166 Thallium		0.100	
167 Vanadium		0.004	
168 Zinc		0.002	

TABLE C-9 (Continued)

BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash)* (mg/kg)	Scrubber Wastewater (mg/l)
<u>Inorganics</u>			
169 Cyanide	-	-	0.01
170 Flouride	-	-	0.2
171 Sulfide	-	-	0.5
<u>Other Parameters</u>			
Chlorides	-	-	1
Sulfates	-	-	5

\* - No samples were taken for Sample Set #5.

(1) - Cannot be separated from N-Nitrosodiphenylamine.

NA - The standard is not available; compound was searched using an NBS library of 42,000 compounds.

ND - Not detected, estimated detection limit has not been determined.

+ - The detection limit for sample set 5 for Nickel is 11 mg/kg.

- - No detection limit has been established.

TABLE C-10 DETECTION LIMITS FOR K102 SAMPLE SET #6

BDAT CONSTITUENT	Untreated	Treated	Scrubber
	Waste to Incinerator (mg/kg)	Waste (Kiln Ash) (mg/kg)	Wastewater (mg/l)
<u>Volatile Organics</u>			
222 Acetone	3		0.010
1 Acetonitrile	30		0.100
2 Acrolein	30		0.100
3 Acrylonitrile	30		0.100
4 Benzene	1.5		0.005
5 Bromodichloromethane	1.5	NO	0.005
6 Bromomethane	3		0.010
223 n-Butyl Alcohol	NA		NA
7 Carbon Tetrachloride	1.5		0.005
8 Carbon Disulfide	1.5		0.005
9 Chlorobenzene	1.5	SAMPLES	0.005
10 2-Chloro-1,3-Butadiene	30		0.100
11 Chlorodibromomethane	1.5		0.005
12 Chloroethane	3		0.010
13 2-Chloroethylvinylether	3	TAKEN	0.010
14 Chloroform	1.5		0.005
15 Chloromethane	3		0.010
16 3-Chloropropene	30		0.100
17 1,2-Dibromo-3-Chloropropane	3		0.010
18 1,2-Dibromoethane	1.5		0.005
19 Dibromomethane	1.5		0.005
20 Trans-1,4-Dichloro-2-Butene	30		0.100
21 Dichlorodifluoromethane	3		0.010
22 1,1-Dichloroethane	1.5		0.005
23 1,2-Dichloroethane	1.5		0.005
24 1,1-Dichloroethene	1.5		0.005
25 Trans-1,2-Dichloroethene	1.5		0.005
26 1,2-Dichloropropane	1.5		0.005
27 Trans-1,3-Dichloropropene	1.5		0.005
28 cis-1,3-Dichloropropene	1.5		0.005
29 1,4-Dioxane	60		0.200
224 2-Ethoxyethanol	NA		NA
225 Ethyl Acetate	NA		NA
226 Ethylbenzene	1.5		0.005
30 Ethyl Cyanide	30		0.100
227 Ethyl Ether	NA		NA
31 Ethyl Methacrylate	30		0.100
214 Ethylene Oxide	NA		NA
32 Iodomethane	15		0.050
33 Isobutyl Alcohol	60		0.200
228 Methanol	NA		NA
Methyl butyl ketone	3		0.010
34 Methyl ethyl ketone	3		0.010
229 Methyl isobutyl ketone	3		0.010
35 Methyl Methacrylate	30		0.100



TABLE C-10 (Continued)

BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash) (mg/kg)	Scrubber Wastewater (mg/l)
<u>Volatile Organics (cont.)</u>			
37 Methacrylonitrile	30		0.100
38 Methylene Chloride	1.5		0.005
230 2-Nitropropane	NA		NA
39 Pyridine	120		0.400
Styrene	1.5		0.005
40 1,1,1,2-Tetrachloroethane	1.5		0.005
41 1,1,2,2-Tetrachloroethane	1.5		0.005
42 Tetrachloroethene	1.5		0.005
43 Toluene	1.5		0.005
44 Tribromomethane(bromoform)	1.5		0.005
45 1,1,1-Trichloroethane	1.5		0.005
46 1,1,2-Trichloroethane	1.5		0.005
47 Trichloroethene	1.5		0.005
48 Trichloromonofluoromethane	1.5		0.005
49 1,2,3-Trichloropropane	1.5		0.005
231 1,1,2-Trichloro-1,2,2-trifluoroethane	NA		NA
Vinyl Acetate	3	NO	0.010
50 Vinyl Chloride	3		0.010
Xylenes	1.5		0.005
<u>Semivolatile Organics</u>			
SAMPLES			
51 Acenaphthalene	184		10
52 Acenaphthene	184		10
53 Acetophenone	368	TAKEN	20
54 2-Acetylaminofluorene	368		20
55 4-Aminobiphenyl	368		20
56 Aniline	184		10
57 Anthracene	184		10
58 Aramite	NA		NA
59 Benzo(a)anthracene	184		10
218 Benzal Chloride	NA		NA
60 Benzenethiol	ND		ND
61 Benzidine	920		50
Benzoic Acid	918		10
62 Benzo(a)pyrene	184		10
63 Benzo(b)fluoranthene	184		10
64 Benzo(g,h,i) perylene	184		10
65 Benzo(k)fluoranthene	1840		10
66 p-Benzoquinone	ND		ND
Benzyl Alcohol	184		10
67 Bis(2-Chloroethoxy) methane	184		10
68 Bis(2-Chloroethyl) Ether	184		10
69 Bis(2-chloroisopropyl) ether	184		10
70 Bis(2-ethylhexyl) phthalate	184		10
71 4-Bromophenyl phenyl ether	184		10

TABLE C-10 (Continued)

BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash) (mg/kg)	Scrubber Wastewater (mg/l)
<u>Semivolatile Organics (cont.)</u>			
72 Butyl benzyl phthalate	184		10
73 2-Sec-Butyl-4,6-Dinitrophenol	920		50
74 p-Chloroaniline	184		10
75 Chlorobenzilate	NA		NA
76 p-Chloro-m-cresol	184		10
77 2-Chloronaphthalene	184		10
78 2-Chlorophenol	184		10
4-Chlorophenyl-phenyl ether	184		10
79 3-Chloropropionitrile	NA		NA
80 Chrysene	184		10
81 Ortho-cresol	184		10
82 para-cresol	184		10
232 Cyclohexanone	ND		ND
83 Dibenz(a,h)anthracene	184		10
Dibenzofuran	184		10
84 Dibenzo(a,e,) Pyrene	NA		NA
85 Dibenzo(a,i) Pyrene	NA		NA
86 1,3-Dichlorobenzene	184		10
87 1,2-Dichlorobenzene	184		10
88 1,4-Dichlorobenzene	184		10
89 3,3'-Dichlorobenzidine	366		20
90 2,4-Dichlorophenol	184	NO	10
91 2,6-Dichlorophenol	ND		ND
92 Diethyl phthalate	184		10
93 3,3'-Dimethoxybenzidine	184		10
94 p-Dimethylaminoazobenzene	368	SAMPLES	20
95 3,3'-Dimethylbenzidine	ND		ND
96 2,4-Dimethylphenol	184		10
97 Dimethyl Phthalate	184		10
98 Di-n-butyl phthalate	184	TAKEN	10
99 1,4-Dinitrobenzene	920		50
100 4,6-dinitro-o-cresol	918		50
101 2,4-Dinitrophenol	918		50
102 2,4-Dinitrotoluene	184		10
103 2,6-Dinitrotoluene	184		10
104 Di-n-octyl phthalate	184		10
105 Di-n-propylnitrosoamine	184		10
106 Diphenylamine (1)	368		20
107 1,2,-Diphenylhydrazine	920		50
108 Fluoranthene	184		10
109 Fluorene	184		10
110 Hexachlorobenzene	184		10
111 Hexachlorobutadiene	184		10
112 Hexachlorocyclopentadiene	184		10
113 Hexachloroethane	184		10
114 Hexachlorophene	NA		NA

TABLE C-10 (Continued)

BDAT CONSTITUENT	Untreated	Treated	Scrubber
	Waste to Incinerator (mg/kg)	Waste (Kiln Ash) (mg/kg)	Wastewater (mg/l)
<u>Semivolatile Organics (cont.)</u>			
115 Hexachloropropene	ND		ND
116 Indeno(1,2,3,-cd) Pyrene	184		10
117 Isosafrole	368		20
Isophorone	184		10
118 Methapyrilene	NA		NA
119 3-Methylcholanthrene	368		20
120 4,4'-Methylene-bis-(2-chloroaniline)	368		20
36 Methyl Methanesulfonate	ND		ND
2-Methylnaphthalene	184		10
121 Naphthalene	184		10
122 1,4-Naphthoquinone	NA		NA
123 1-Naphthylamine	920		50
124 2-Naphthylamine	920		50
2-Nitroaniline	918		50
3-Nitroaniline	918		50
125 p-Nitroaniline	918		50
126 Nitrobenzene	184		10
2-Nitrophenol	184		10
127 4-Nitrophenol	918		50
128 N-Nitrosodi-n-butylamine	ND		ND
129 N-Nitrosodiethylamine	ND		ND
130 N-Nitrosodimethylamine	184		10
219 N-Nitrosodiphenylamine (1)	184		10
131 N-Nitrosomethylethylamine	184	NO	10
132 N-Nitrosomorpholine	368		20
133 1-Nitrosopiperidine	184		10
134 N-Nitrosopyrrolidine	920		50
135 5-Nitro-o-toluidine	368	SAMPLES	20
136 Pentachlorobenzene	ND		ND
137 Pentachloroethane	NA		NA
138 Pentachloronitrobenzene	1840		100
139 Pentachlorophenol	918	TAKEN	50
140 Phenacetin	368		20
141 Phenanthrene	184		10
142 Phenol	184		10
220 Phthalic Anhydride	ND		ND
143 2-Picoline	184		10
144 Pronamide	ND		ND
145 Pyrene	184		10
146 Resorcinol	NA		NA
147 Safrole	920		50
148 1,2,4,5-Tetrachlorobenzene	368		20
149 2,3,4,6-Tetrachlorophenol	ND		ND
150 1,2,4-Trichlorobenzene	184		10
151 2,4,5-Trichlorophenol	918		50
152 2,4,6-Trichlorophenol	184		10
153 Tris(2,3-dibromopropyl) phosphate	ND		ND

TABLE C-10 (Continued)

BDAT CONSTITUENT	Untreated Waste to Incinerator (mg/kg)	Treated Waste (Kiln Ash) (mg/kg)	Scrubber Wastewater (mg/L)
<u>Metals - Total Composition</u>			
154 Antimony	1.5		0.015
155 Arsenic	1.0		0.010
156 Barium	0.2		0.002
157 Beryllium	0.1		0.001
158 Cadmium	0.5		0.005
159 Chromium	0.5		0.005
221 Hexavalent Chromium (mg/L)	0.01		0.010
160 Copper	0.4		0.004
161 Lead	0.5		0.005
162 Mercury	0.1		0.0002
163 Nickel	11		0.009
164 Selenium	0.5		0.005
165 Silver	0.7		0.005
166 Thallium	0.1		0.010
167 Vanadium	0.3		0.003
168 Zinc	0.2		0.002
<u>Metals - TCLP (mg/L)</u>			
154 Antimony			
155 Arsenic			
156 Barium			
157 Beryllium	NOT		NOT
158 Cadmium			
159 Chromium		NO	
160 Copper	ANALYZED		ANALYZED
161 Lead			
162 Mercury		SAMPLES	
163 Nickel			
164 Selenium			
165 Silver			
166 Thallium		TAKEN	
167 Vanadium			
168 Zinc			
<u>Inorganics</u>			
169 Cyanide	-		0.01
170 Flouride	-		0.2
171 Sulfide	-		0.5
<u>Other Parameters</u>			
Chlorides	-		1
Sulfates	-		5

(1) - Cannot be separated from N-Nitrosodiphenylamine.

NA - The standard is not available; compound was searched using an NBS library of 42,000 compounds.

ND - Not detected, estimated detection limit has not been determined.

- - Detection have not been established.

APPENDIX D

Calculation of Treatment Standards for K101 Nonwastewaters

Constituent: Acetone

Sample Set	1	2+	3*	4	5
	Kiln Ash Concentration (mg/kg)	Percent Recovery	Accuracy Correction Factor	Corrected Concentration (mg/kg)	Log Transform
1	0.010	106	1.0	0.010	-4.605
2	0.010	106	1.0	0.010	-4.605
3	0.010	106	1.0	0.010	-4.605
x =				0.010	y = -4.605
					s = 0.000

- 1 - Obtained from the Onsite Engineering Report, John Zink Company for K101, Table 5-7.  
2 - Obtained from the Onsite Engineering Report, John Zink Company for K101, Table 6-15.  
+ - Values are actually the average of all volatiles.  
3 - Accuracy Correction Factor = 100 / Percent Recovery.  
\* - Corrected concentration cannot be below the detection limit;  
therefore, the accuracy factor is adjusted to 1.0.  
4 - Corrected Concentration = Kiln Ash Concentration X Accuracy Correction Factor.  
5 - Log Transform using the natural logarithm, ln, of the Corrected Concentration.

Treatment Standard = Corrected Kiln Ash Mean X VF

VF = 2.8 (as explained in Appendix A)

Treatment Standard = Corrected Kiln Ash Mean X VF  
= 0.010 X 2.8  
= 0.028 mg/kg

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# APPENDIX D

## Calculation of Treatment Standards for K101 Nonwastewaters

Constituent: Toluene

Sample Set	1	2	3*	4	5
	Kiln Ash Concentration (mg/kg)		Accuracy Correction Factor	Corrected Concentration (mg/kg)	
1	0.005	106	1.0	0.005	-5.298
2	0.005	106	1.0	0.005	-5.298
3	0.005	106	1.0	0.005	-5.298
x =				0.005	y = -5.298
					s = 0.000

- 1 - Obtained from the Onsite Engineering Report, John Zink Company for K101, Table 5-7.  
2 - Obtained from the Onsite Engineering Report, John Zink Company for K101, Table 6-15.  
3 - Accuracy Correction Factor = 100 / Percent Recovery.  
\* - Corrected concentration cannot be below the detection limit;  
therefore, the accuracy factor is adjusted to 1.0. .  
4 - Corrected Concentration = Kiln Ash Concentration X Accuracy Correction Factor.  
5 - Log Transform using the natural logarithm, ln, of the Corrected Concentration.

Treatment Standard = Corrected Kiln Ash Mean X VF

VF = 2.8 (as explained in Appendix A)

Treatment Standard = Corrected Kiln Ash Mean X VF  
= 0.005 X 2.8  
= 0.014 mg/kg

APPENDIX D

Calculation of Treatment Standards for K101 Nonwastewaters

Constituent: Aniline

Sample Set	1	2+	3	4	5
	Kiln Ash Concentration (mg/kg)	Percent Recovery	Accuracy Correction Factor	Corrected Concentration (mg/kg)	Log Transform
1	0.420	40	2.5	1.05	0.049
2	0.420	40	2.5	1.05	0.049
3	0.420	40	2.5	1.05	0.049
x =				1.05	y = 0.049
					s = 0.000

- 1 - Obtained from the Onsite Engineering Report, John Zink Company for K101, Table 5-7.  
2 - Obtained from the Onsite Engineering Report, John Zink Company for K101, Table 6-16.  
+ - Values are actually the average of all semivolatiles.  
3 - Accuracy Correction Factor =  $100 / \text{Percent Recovery}$ .  
4 - Corrected Concentration = Kiln Ash Concentration X Accuracy Correction Factor.  
5 - Log Transform using the natural logarithm,  $\ln$ , of the Corrected Concentration.

Treatment Standard = Corrected Kiln Ash Mean X VF

VF = 2.8 (as explained in Appendix A)

Treatment Standard = Corrected Kiln Ash Mean X VF  
=  $1.05 \times 2.8$   
= 2.940 mg/kg

---

#### APPENDIX D

##### Calculation of Treatment Standards for K101 Nonwastewaters

Constituent: 2-Nitroaniline

Sample Set	Kiln Ash Concentration (mg/kg)	1 Percent Recovery	Accuracy 3 2+ Correction Factor	Corrected 4 Concentration (mg/kg)	Log 5 Transform
1	2.0	40	2.50	5.000	1.609
2	2.0	40	2.50	5.000	1.609
3	2.0	40	2.50	5.000	1.609
x =				5.000	y = 1.609
					s = 0.000

- 1 - Obtained from the Onsite Engineering Report for John Zink Company for K101, Table 5-7.  
2 - Obtained from the Onsite Engineering Report for John Zink Company for K101, Table 6-16.  
+ - Values are actually the average of all semivolatiles.  
3 - Accuracy Correction Factor =  $100 / \text{Percent Recovery}$ .  
4 - Corrected Concentration = Kiln Ash Concentration X Accuracy Correction Factor.  
5 - Log Transform using the natural logarithm,  $\ln$ , of the Corrected Concentration.

Treatment Standard = Corrected Kiln Ash Mean X VF

VF = 2.8 (as explained in Appendix A)

Treatment Standard = Corrected Kiln Ash Mean X VF  
=  $5.000 \times 2.80$   
= 14.000 mg/kg



# APPENDIX D

## Calculation of Treatment Standards for K102 Nonwastewaters

Constituent: Toluene

Sample Set	1	2	3*	4	5
	Kiln Ash Concentration (mg/kg)		Accuracy Correction Factor	Corrected Concentration (mg/kg)	Log Transform
1	1.5	112	1.0	1.500	0.405
2	1.5	112	1.0	1.500	0.405
3	1.5	112	1.0	1.500	0.405
4	1.5	112	1.0	1.500	0.405
x =				1.500	y = 0.405
					s = 0.000

- 1 - Obtained from the Onsite Engineering Report, John Zink Company for K102, Table 5-7.  
2 - Obtained from the Onsite Engineering Report, John Zink Company for K102, Table 6-15.  
3 - Accuracy Correction Factor =  $100 / \text{Percent Recovery}$ .  
\* - Corrected concentration cannot be below the detection limit;  
therefore, the accuracy factor is adjusted to 1.0.  
4 - Corrected Concentration = Kiln Ash Concentration X Accuracy Correction Factor.  
5 - Log Transform using the natural logarithm,  $\ln$ , of the Corrected Concentration.

Treatment Standard = Corrected Kiln Ash Mean X VF

VF = 2.8 (as explained in Appendix A)

Treatment Standard = Corrected Kiln Ash Mean X VF  
=  $1.500 \times 2.8$   
= 4.200 mg/kg

APPENDIX D

Calculation of Treatment Standards for K102 Nonwastewaters

Constituent: Total Xylenes

Sample Set	1	2+	3*	4	5
	Kiln Ash Concentration (mg/kg)	Percent Recovery	Accuracy Correction Factor	Corrected Concentration (mg/kg)	Log Transform
1	1.5	112	1.0	1.500	0.405
2	1.5	112	1.0	1.500	0.405
3	1.5	112	1.0	1.500	0.405
4	1.5	112	1.0	1.500	0.405
x =				1.500	y = 0.405 s = 0.000

- 1 - Obtained from the Onsite Engineering Report, John Zinc Company for K102, Table 5-7.  
2 - Obtained from the Onsite Engineering Report, John Zinc Company for K102, Table 6-15.  
+ - Values are actually the average of all volatiles.  
3 - Accuracy Correction Factor =  $100 / \text{Percent Recovery}$ .  
\* - Corrected concentration cannot be below the detection limit;  
therefore, the accuracy factor is adjusted to 1.0.  
4 - Corrected Concentration = Kiln Ash Concentration X Accuracy Correction Factor.  
5 - Log Transform using the natural logarithm,  $\ln$ , of the Corrected Concentration.

Treatment Standard = Corrected Kiln Ash Mean X VF

VF = 2.8 (as explained in Appendix A)

Treatment Standard = Corrected Kiln Ash Mean X VF  
=  $1.500 \times 2.8$   
= 4.200 mg/kg

APPENDIX D

Calculation of Treatment Standards for K102 Nonwastewaters

Constituent: 2-Nitrophenol

Sample Set	Kiln Ash Concentration (mg/kg)	1 Percent Recovery	Accuracy 3 Correction Factor	Corrected 4 Concentration (mg/kg)	Log 5 Transform
1	1.0	21	4.76	4.760	1.560
2	1.0	21	4.76	4.760	1.560
3	1.0	21	4.76	4.760	1.560
4	1.0	21	4.76	4.760	1.560
x =				4.760	y = 1.560
					s = 0.000

- 1 - Obtained from the Onsite Engineering Report for John Zink Company for K102, Table 5-3 through 5-6.
- 2 - Obtained from the Onsite Engineering Report for John Zink Company for K102, Table 6-16.  
+ - Values are actually the value for the isomer 4-Nitrophenol.
- 3 - Accuracy Correction Factor =  $100 / \text{Percent Recovery}$ .
- 4 - Corrected Concentration = Kiln Ash Concentration X Accuracy Correction Factor.
- 5 - Log Transform using the natural logarithm,  $\ln$ , of the Corrected Concentration.

Treatment Standard = Corrected Kiln Ash Mean X VF

VF = 2.8 (as explained in Appendix A)

Treatment Standard = Corrected Kiln Ash Mean X VF  
=  $4.760 \times 2.80$   
= 13.328 mg/kg

---

APPENDIX D

Calculation of Treatment Standards for K102 Nonwastewaters

Constituent: Phenol

Sample Set	1	2	3	4	5
	Kiln Ash Concentration (mg/kg)		Accuracy Correction Factor	Corrected Concentration (mg/kg)	Log Transform
1	1.0	61	1.64	1.640	0.495
2	1.0	61	1.64	1.640	0.495
3	1.0	61	1.64	1.640	0.495
4	1.0	61	1.64	1.640	0.495
x =				1.640	y = 0.495
					s = 0.000

- 1 - Obtained from the Onsite Engineering Report, John Zinc Company, Table 5-7.  
2 - Obtained from the Onsite Engineering Report, John Zinc Company, Table 6-16.  
3 - Accuracy Correction Factor = 100 / Percent Recovery.  
4 - Corrected Concentration = Kiln Ash Concentration X Accuracy Correction Factor.  
5 - Log Transform using the natural logarithm, ln, of the Corrected Concentration.

Treatment Standard = Corrected Kiln Ash Mean X VF

VF = 2.8 (as explained in Appendix A)

Treatment Standard = Corrected Effluent Mean X VF  
= 1.640 X 2.8  
= 4.592 mg/kg

---

## APPENDIX D

### Calculation of Treatment Standards for K101 Wastewaters

Constituent: 2-Nitroaniline

Sample Set	Effluent Concentration (mg/l)	1 Percent Recovery	Accuracy 3 Correction Factor	Corrected 4 Concentration (mg/l)	Log 5 Transform
1	0.050	53	1.89	0.095	-2.354
2	0.050	53	1.89	0.095	-2.354
3	0.050	53	1.89	0.095	-2.354
4	0.050	53	1.89	0.095	-2.354
x =				0.095	y = -2.354
					s = 0.000

1 - Obtained from the Onsite Engineering Report for John Zink Company, Tables 5-3 to 5-6.

2 - Obtained from the Onsite Engineering Report for John Zink Company, Table 6-19.

+ - Values are actually the average of all semivolatiles.

3 - Accuracy Correction Factor =  $100 / \text{Percent Recovery}$ .

4 - Corrected Concentration = Effluent Concentration X Accuracy Correction Factor.

5 - Log Transform using the natural logarithm, ln, of the Corrected Concentration.

Treatment Standard = Corrected Effluent Mean X VF

VF = 2.8 (as explained in Appendix A)

Treatment Standard = Corrected Effluent Mean X VF

=  $0.095 \times 2.8$

= 0.266 mg/l

# APPENDIX D

## Calculation of Treatment Standards for K102 Wastewaters

Constituent: 2-Nitrophenol

Sample Set	Effluent Concentration (mg/l)	1 Percent Recovery	Accuracy 3* 2+ Correction Factor	Corrected 4 Concentration (mg/l)	Log 5 Transform
1	0.010	113	1.0	0.010	-4.605
2	0.010	113	1.0	0.010	-4.605
3	0.010	113	1.0	0.010	-4.605
4	0.010	113	1.0	0.010	-4.605
5	0.010	113	1.0	0.010	-4.605
6	0.010	113	1.0	0.010	-4.605

$$\begin{aligned}x &= 0.010 & y &= -4.605 \\s &= 0\end{aligned}$$

1 - Obtained from the Onsite Engineering Report for John Zink Company, Tables 5-3 to 5-8.

2 - Obtained from the Onsite Engineering Report for John Zink Company, Table 6-19.

+ - Values are actually for the isomer 4-nitrophenol.

3 - Accuracy Correction Factor = 100 / Percent Recovery.

\* - Corrected concentration cannot be below the detection limit;  
therefore, the accuracy factor is adjusted to 1.0.

4 - Corrected Concentration = Effluent Concentration X Accuracy Correction Factor.

5 - Log Transform using the natural logarithm, ln, of the Corrected Concentration.

Treatment Standard = Corrected Effluent Mean X VF

VF = 2.8 (as explained in Appendix A)

Treatment Standard = Corrected Effluent Mean X VF

= 0.010 X 2.80

= 0.028 mg/l

# APPENDIX D

## Calculation of Treatment Standards for K101 and K102 Wastewaters

Constituent: Arsenic

Sample Set	Effluent Concentration (mg/l)	1 Percent Recovery	Accuracy Correction Factor	3 Corrected Concentration (mg/l)	4 Log 5 Transform
1	0.415	143	0.70	0.291	-1.234
2	2.000	143	0.70	1.400	0.336
3	0.513	143	0.70	0.359	-1.024
4	0.418	143	0.70	0.293	-1.228
5	0.440	143	0.70	0.308	-1.178
x =				0.530	y = -0.866
					s = 0.677

- 1 - Obtained from the Onsite Engineering Report for D004, Table 5-15
- 2 - Obtained from the Onsite Engineering Report for D004, Table 6-14
- 3 - Accuracy Correction Factor = 100 / Percent Recovery.
- 4 - Corrected Concentration = Effluent Concentration X Accuracy Correction Factor.
- 5 - Log Transform using the natural logarithm, ln, of the Corrected Concentration.

Treatment Standard = Corrected Effluent Mean X VF

Calculation of Variability Factor (VF):

$$C_{99} = \exp (y + 2.33s)$$

where y = the mean of the log transforms  
s = the standard deviation of the log transforms.

$$\begin{aligned} \text{Therefore, } C_{99} &= \exp (-0.866 + 2.33(0.677)) \\ &= \exp (0.711) \\ &= 2.036 \end{aligned}$$

$$\text{and VF} = C_{99} / x$$

where x = the mean of the corrected effluent concentrations.

$$\begin{aligned} \text{Therefore, VF} &= C_{99} / x \\ &= 2.036 / 0.530 \\ &= 3.842 \end{aligned}$$

$$\begin{aligned} \text{Treatment Standard} &= \text{Corrected Effluent Mean X VF} \\ &= 0.530 \times 3.842 \\ &= 2.036 \text{ mg/l} \end{aligned}$$

# APPENDIX D

## Calculation of Treatment Standards for K101 and K102 Wastewaters

Constituent: Cadmium

Sample Set	Effluent Concentration (mg/l)	1 Percent Recovery	Accuracy 3 Correction Factor	Corrected 4 Concentration (mg/l)	Log 5 Transform
1	0.080	94	1.06	0.085	-2.465
2	0.080	94	1.06	0.085	-2.465
3	0.080	94	1.06	0.085	-2.465
4	0.080	94	1.06	0.085	-2.465
5	0.080	94	1.06	0.085	-2.465

$$x = 0.085 \quad y = -2.465$$

$$s = 0.000$$

- 1 - Obtained from the Onsite Engineering Report for D004, Table 5-15
- 2 - Obtained from the Onsite Engineering Report for D004, Table 6-14
- 3 - Accuracy Correction Factor =  $100 / \text{Percent Recovery}$ .
- 4 - Corrected Concentration = Effluent Concentration X Accuracy Correction Factor.
- 5 - Log Transform using the natural logarithm,  $\ln$ , of the Corrected Concentration.

Treatment Standard = Corrected Effluent Mean X VF

Calculation of Variability Factor (VF):

$$C_{99} = \exp (y + 2.33s)$$

where  $y$  = the mean of the log transforms  
 $s$  = the standard deviation of the log transforms.

$$\begin{aligned} \text{Therefore, } C_{99} &= \exp (-2.465 + 2.33(0.0)) \\ &= \exp (-2.465) \\ &= 0.085 \end{aligned}$$

and  $VF = C_{99} / x$   
 where  $x$  = the mean of the corrected effluent concentrations.

$$\begin{aligned} \text{Therefore, } VF &= C_{99} / x \\ &= 0.085 / 0.085 \\ &= 1.0 \end{aligned}$$

A variability factor of one was not used in calculating the treatment standards.  
 The variability factor of 2.80 was substituted for the value 1.

$$\begin{aligned} \text{Treatment Standard} &= \text{Corrected Effluent Mean} \times VF \\ &= 0.085 \times 2.80 \\ &= 0.238 \text{ mg/l} \end{aligned}$$



# APPENDIX D

## Calculation of Treatment Standards for K101 and K102 Wastewaters

Constituent: Lead

Sample Set	Effluent 1 Concentration (mg/l)	Percent 2 Recovery	Accuracy 3 Correction Factor	Corrected 4 Concentration (mg/l)	Log 5 Transform
1	0.005	84	1.19	0.006	-5.116
2	0.029	84	1.19	0.035	-3.352
3	0.025	84	1.19	0.030	-3.507
4	0.010	84	1.19	0.012	-4.423
5	0.025	84	1.19	0.030	-3.507
x =				0.023	y = -3.981
					s = 0.763

- 1 - Obtained from the Onsite Engineering Report for D004, Table 5-15
- 2 - Obtained from the Onsite Engineering Report for D004, Table 6-14
- 3 - Accuracy Correction Factor = 100 / Percent Recovery.
- 4 - Corrected Concentration = Effluent Concentration X Accuracy Correction Factor.
- 5 - Log Transform using the natural logarithm, ln, of the Corrected Concentration.

Treatment Standard = Corrected Effluent Mean X VF

Calculation of Variability Factor (VF):

$$C_{99} = \exp (y + 2.33s)$$

where y = the mean of the log transforms

s = the standard deviation of the log transforms.

$$\begin{aligned} \text{Therefore, } C_{99} &= \exp (-3.981 + 2.33(0.763)) \\ &= \exp (-2.203) \\ &= 0.110 \end{aligned}$$

$$\text{and VF} = C_{99} / x$$

where x = the mean of the corrected effluent concentrations.

$$\begin{aligned} \text{Therefore, VF} &= C_{99} / x \\ &= 0.110 / 0.023 \\ &= 4.783 \end{aligned}$$

$$\begin{aligned} \text{Treatment Standard} &= \text{Corrected Effluent Mean X VF} \\ &= 0.023 \times 4.783 \\ &= 0.110 \text{ mg/l} \end{aligned}$$

# APPENDIX D

## Calculation of Treatment Standards for K101 and K102 Wastewaters

Constituent: Mercury

Sample Set	Effluent Concentration (mg/l)	1 Percent Recovery	Accuracy 3 Correction Factor	Corrected 4 Concentration (mg/l)	Log 5 Transform
1	0.001	95	1.05	0.001	-6.908
2	0.004	95	1.05	0.004	-5.521
3	0.009	95	1.05	0.009	-4.711
4	0.004	95	1.05	0.004	-5.521
5	0.006	95	1.05	0.006	-5.116
x =				0.005	y = -5.555
					s = 0.827

1 - Obtained from the Onsite Engineering Report for D004, Table 5-15

2 - Obtained from the Onsite Engineering Report for D004, Table 6-14

3 - Accuracy Correction Factor = 100 / Percent Recovery.

4 - Corrected Concentration = Effluent Concentration X Accuracy Correction Factor.

5 - Log Transform using the natural logarithm, ln, of the Corrected Concentration.

Treatment Standard = Corrected Effluent Mean X VF

Calculation of Variability Factor (VF):

$$C_{99} = \exp (y + 2.33s)$$

where y = the mean of the log transforms

s = the standard deviation of the log transforms.

$$\begin{aligned} \text{Therefore, } C_{99} &= \exp (-5.555 + 2.33(0.827)) \\ &= \exp (-3.628) \\ &= 0.027 \end{aligned}$$

$$\text{and VF} = C_{99} / x$$

where x = the mean of the corrected effluent concentrations.

$$\begin{aligned} \text{Therefore, VF} &= C_{99} / x \\ &= 0.027 / 0.005 \\ &= 5.400 \end{aligned}$$

$$\begin{aligned} \text{Treatment Standard} &= \text{Corrected Effluent Mean X VF} \\ &= 0.005 \times 5.400 \\ &= 0.027 \text{ mg/l} \end{aligned}$$

## APPENDIX E

### THERMAL CONDUCTIVITY

The comparative method of measuring thermal conductivity has been proposed as an ASTM test method under the name "Guarded, Comparative, Longitudinal Heat Flow Technique". A thermal heat flow circuit is used which is the analog of an electrical circuit with resistances in series. A reference material is chosen to have a thermal conductivity close to that estimated for the sample. Reference standards (also known as heat meters) having the same cross-sectional dimensions as the sample are placed above and below the sample. An upper heater, a lower heater, and a heat sink are added to the "stack" to complete the heat flow circuit. See Figure. 1.

The temperature gradients (analogous to potential differences) along the stack are measured with type K (chromel/alumel) thermocouples placed at known separations. The thermocouples are placed into holes or grooves in the references and also in the sample whenever the sample is thick enough to accommodate them.

For molten samples, pastes, greases, and other materials that must be contained, the material is placed into a cell consisting of a top and bottom of Pyrex 7740 and a containment ring of marinite. The sample is 2 inch in diameter and .5 inch

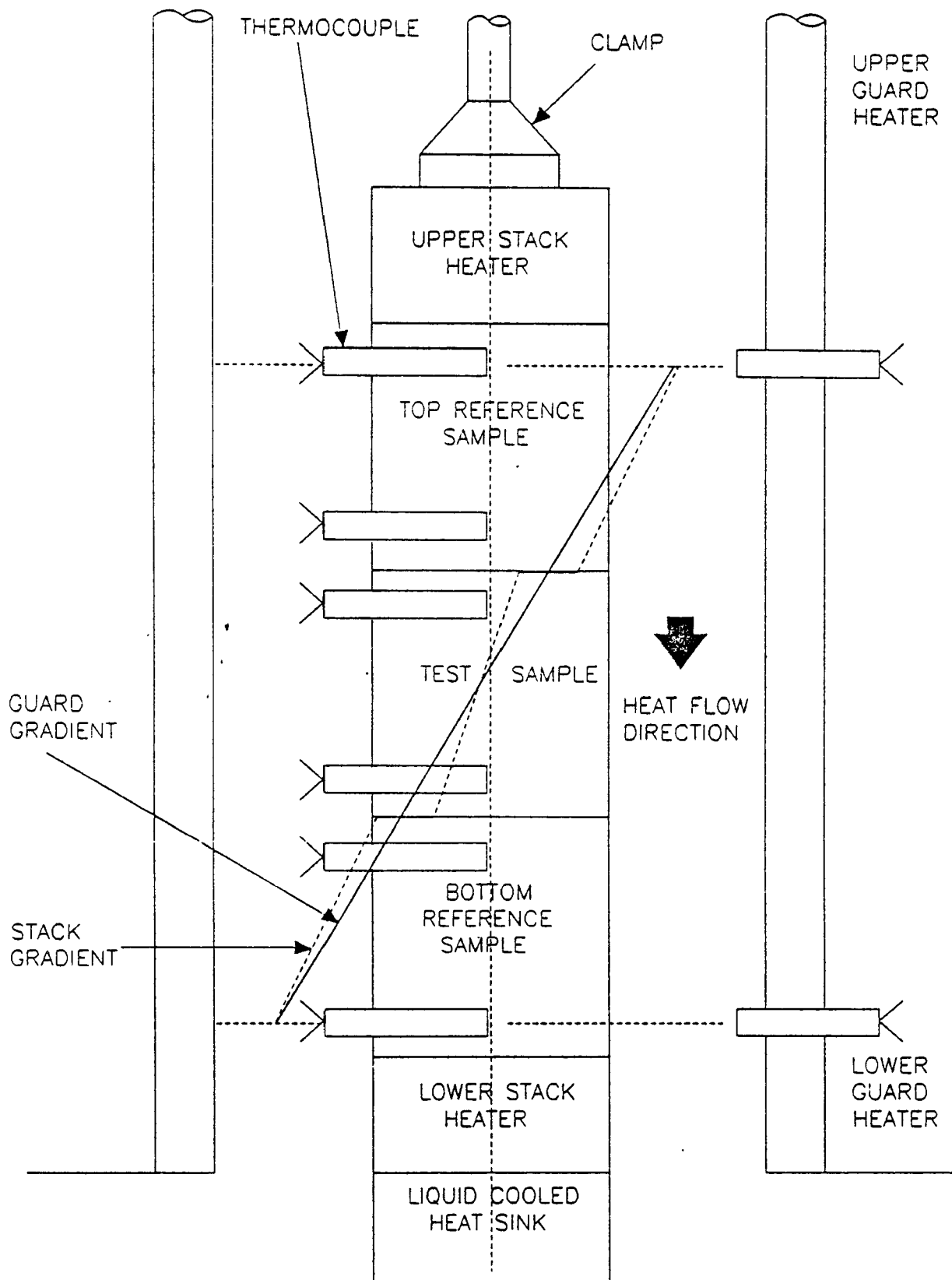


FIGURE 1 SCHEMATIC DIAGRAM OF THE COMPARATIVE METHOD

thick. Thermocouples are not placed into the sample but rather the temperatures measured in the Pyrex are extrapolated to give the temperature at the top and bottom surfaces of the sample material. The Pyrex disks also serve as the thermal conductivity reference material.

The stack is clamped with a reproducible load to insure intimate contact between the components. In order to produce a linear flow of heat down the stack and reduce the amount of heat that flows radially, a guard tube is placed around the stack and the intervening space is filled with insulating grains or powder. The temperature gradient in the guard is matched to that in the stack to further reduce radial heat flow.

The comparative method is a steady state method of measuring thermal conductivity. When equilibrium is reached, the first flux (analogous to current flow) down the stack can be determined from the references. The heat into the sample is given by

$$Q_{in} = \lambda_{top} (dT/dx)_{top}$$

and the heat out of the sample is given by

$$Q_{out} = \lambda_{bottom} (dT/dx)_{bottom}$$

where

$\lambda$  = thermal conductivity

$dT/dx$  = temperature gradient

and top refers to the upper reference while bottom refers to the lower reference. If the heat was confined to flow just down the stack, then  $Q_{in}$  and  $Q_{out}$  would be equal. If  $Q_{in}$  and  $Q_{out}$  are in reasonable agreement, the average heat flow is calculated from

$$Q = (Q_{in} + Q_{out})/2$$

The sample thermal conductivity is then found from

$$\lambda_{sample} = Q/(dT/dx)_{sample}$$

The result for the K102 Activated Charcoal Waste tested is given in Table 1. The sample was held at an average temperature of 42°C with a 53°C temperature drop across the sample for approximately 20 hours before the temperature profile became steady and the conductivity measured. At the conclusion of the test, it appeared that some "drying" of the sample had occurred.

The result for the K101 waste tested is given in Table 1. The sample was held at an average temperature of 39°C with a 39°C temperature drop across the sample for approximately 4 hours

before the temperature profile became steady and the conductivity measured. At the conclusion of the test, it appeared that some "drying" of the sample had occurred. Bubbles had formed in the sample and migrated to the top of the sample in contact with the upper reference. Approximately 15% of the upper Pyrex reference was not in contact with the sample when thermal equilibrium was reached. Thus, the conductivity given in Table 1 may be low by 5 to 10%.

TABLE 1  
THE RESULTS OF THE MEASUREMENT OF THE THERMAL  
CONDUCTIVITY USING THE COMPARATIVE METHOD

Sample	Temperature	Thermal Conductivity
	(°C)	(W/mK) *
K101 Waste	39	.273
K102 Activated Charcoal Waste	42	.136

\*1 W/mK = 6.933 BTU in/h ft<sup>2</sup> °F = .5778 BTU/h ft °F

## Appendix F

Continuous Emissions Monitoring Report  
and  
Strip Charts for Engineering Site Visit



Results of Arsenic Emissions Sampling  
and Continuous Emissions Monitoring for K101 and K102 Waste Incineration  
At  
John Zink Company, Tulsa, OK

Prepared By:

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Process Engineering

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February 5, 1988

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Arsenic Emissions Sampling and Continuous  
Emissions Monitoring At John Zink

1.0 INTRODUCTION

2.0 ARSENIC EMISSIONS SAMPLING

3.0 SAMPLE ANALYSIS

4.0 ARSENIC SAMPLING RESULTS

5.0 CONTINUOUS EMISSIONS MONITORING

APPENDIX: TEST SUMMARIES AND RAW DATA FROM ARSENIC SAMPLING

## 1.0

## INTRODUCTION

Radian Corporation was contracted by Versar, Inc. to provide arsenic emissions sampling and continuous emissions monitoring at the John Zink Company's Tulsa, Oklahoma facility during the week of December 1, 1987. This work was performed in association with the EPA's program to develop treatment standards for wastes subject to land disposal restrictions. Radian Corporation's sampling efforts were conducted under the direction of Darrell Doerle and coordinated with the project manager, Mr. Robert Morton, of the Jacobs Engineering Group, Inc. The purpose of the emissions sampling was to monitor arsenic emissions created by incineration of the arsenic containing hazardous waste K102. The continuous emissions monitoring provided documentation of CO, CO<sub>2</sub>, O<sub>2</sub>, and total hydrocarbon emissions from the afterburner during incineration of wastes K102 and K101. The following is a brief discussion of the sampling and analytical procedures used as well as presentation of the results.

## 2.0

## ARSENIC EMISSIONS SAMPLING

Three flue gas (emissions) samples were taken during the incineration of waste K102 for the determination of arsenic emissions. Total arsenic emissions are reported in the form of arsenic trioxide at the request of the State of Oklahoma. Samples were taken in accordance with protocols delineated in EPA Method 108 (Code of Federal Regulations Part 61, Appendix B).

Pallflex filters (type 2500 QAT-UP) were used for particulate phase collection of arsenic. These filters were selected for their low metals content as well as applicability to EPA Method 5 particulate sampling. Filter temperature was maintained at  $248^{\circ} \pm 25^{\circ}\text{F}$  for all samples. An effort was made to keep filter temperatures at the hotter end of the allowable range due to the low stack temperature and high moisture content. Figure 1-1 illustrates the sampling train that was used.

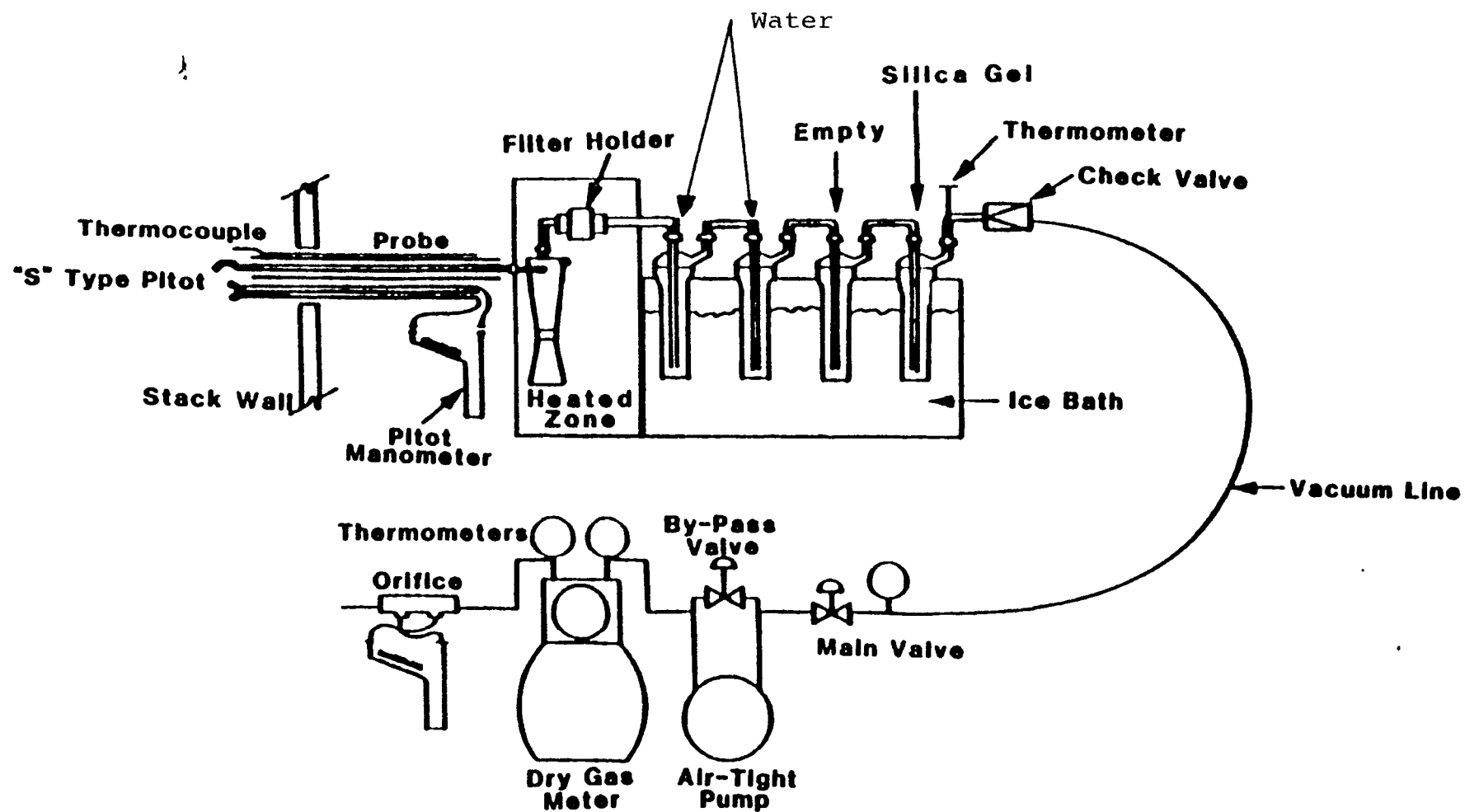


Figure 1-1 Components of the EPA Method 108 sampling train

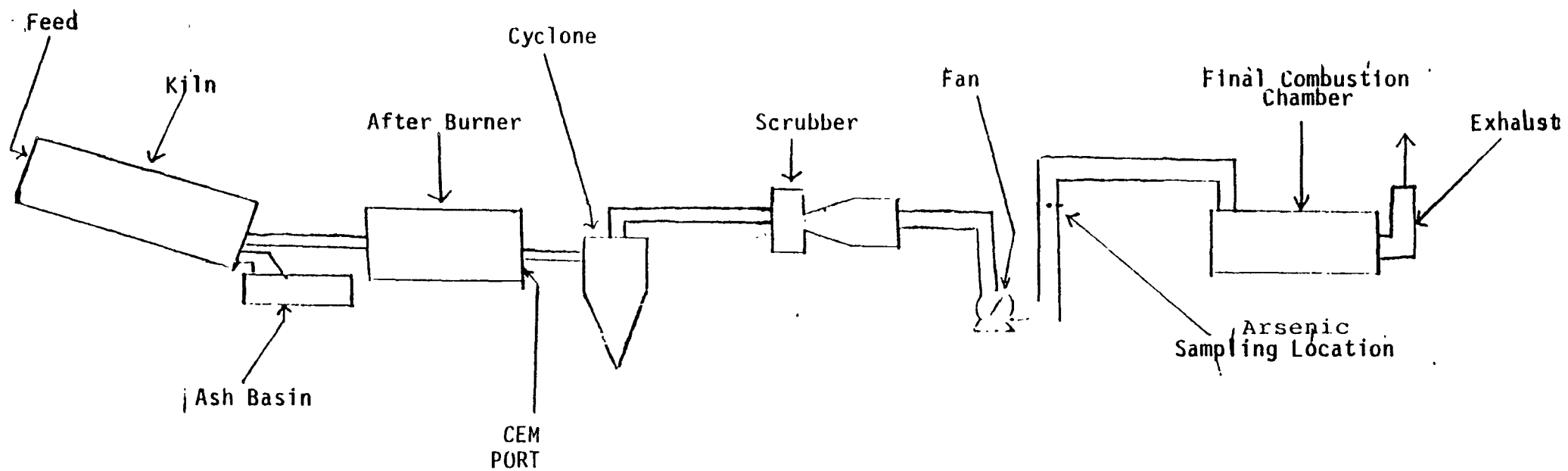


Figure 1-2. Gas Flow Schematic

Samples were taken in a twelve inch vertical duct located approximately 30 feet downstream of the scrubber outlet and 12 feet upstream of the final combustion chamber (Figure 1-2). Access to the gas stream was through two three inch ports set at 90<sup>0</sup> to each other and located eight feet downstream, three feet upstream from the nearest gas flow disturbance. Six points were sampled per port for five minutes each (60 minute test) for each of the three emissions samples that were collected. A schematic of the test matrix is shown in Figure 1-3.

At the beginning of the incineration test burn, there was a three hour supply of K102 waste for incinerator feed. In order to allow for time between collection of emissions samples and possible sampling problems, collection of the second sample was started halfway through collection of the first sample (at the port change). Collection of the third emission sample began following completion of the second sample.

After sample collection the sampling train impingers were weighed for gravimetric moisture determination. The trains were then recovered in the following three components:

- 1) 0.1N NaOH rinses of probe, nozzle, and front half glassware;
- 2) filter;
- 3) back half impinger catch and 0.1N NaOH rinses of back half glassware.

Recovery containers were sealed, labeled, and logged into a master sample log book.

### 3.0 SAMPLE ANALYSIS

Samples to be analyzed for arsenic were taken to Carla Lance of National Analytical Laboratories (NAL) in Tulsa, Oklahoma. Due to the high amount of arsenic found in the samples, NAL performed inductively coupled argon plasma spectroscopy (ICAP) to provide higher resolution over a wider range of concentrations than would be possible by atomic absorption.

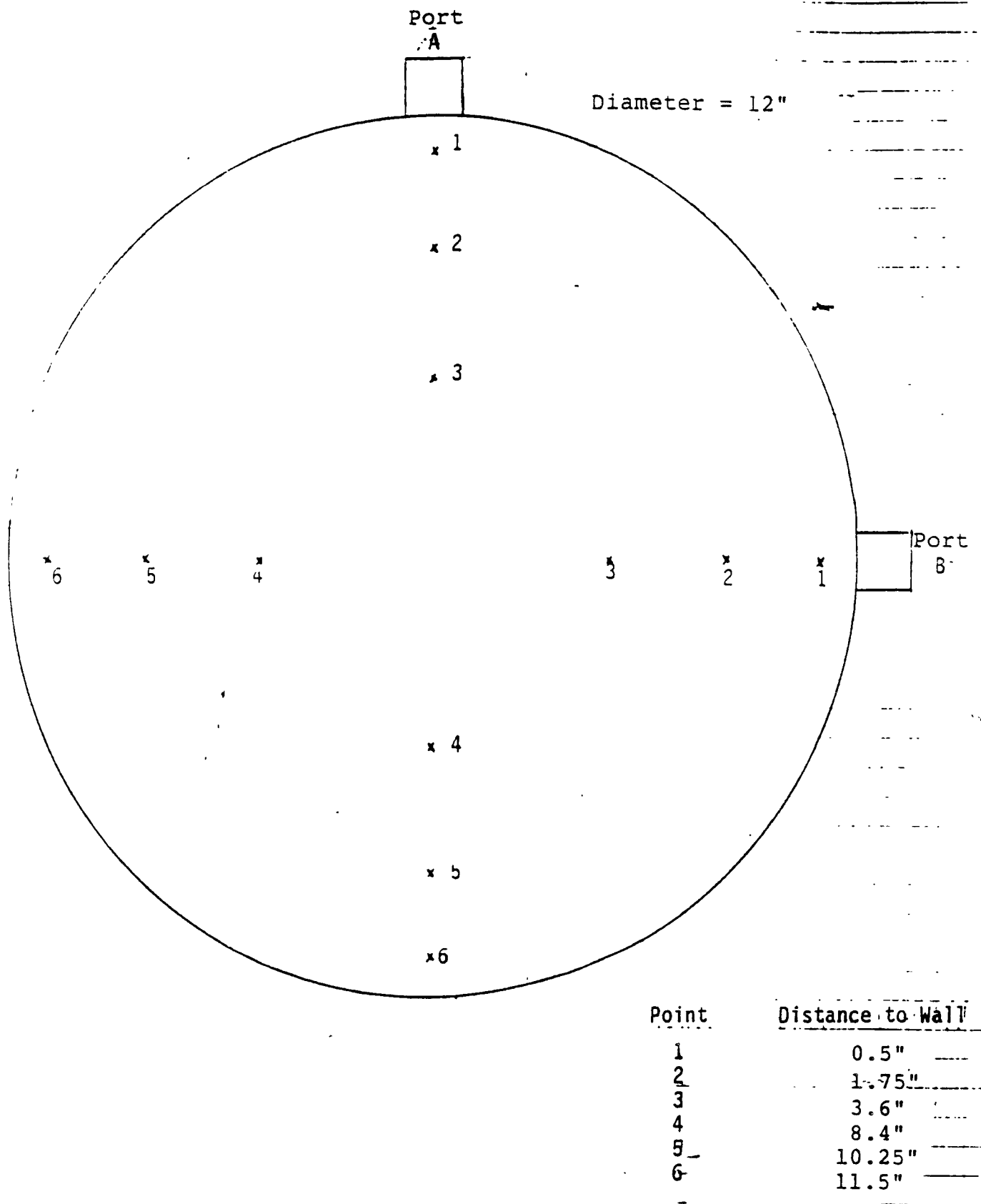


Figure 1-3. Cross Sectional Schematic of Emission Sampling Location

spectroscopy. Prior to analysis front half fractions were combined into one fraction, as were back half fractions. Analysis was then performed to determine total front half arsenic and total back half arsenic for each of the three samples collected.

#### 4.0 ARSENIC SAMPLING RESULTS

The results of the arsenic testing can be found in Table 3-1. Complete test summaries and the raw data are found in the appendix. In calculating arsenic trioxide emissions from total arsenic emissions, it was assumed all arsenic was oxidized to  $\text{As}_2\text{O}_3$  in the final combustion chamber. As shown in the table, the arsenic trioxide emission rate ranged from 0.0067 to 0.0139 kg/hr. The following two factors may have contributed to the apparent rise in arsenic emissions rates over time:

- 1) Feed of K102 waste to the incinerator began approximately 20 minutes after the stack samplers were instructed to begin collection of the first arsenic emissions sample; however, the emission rates were calculated based on the total time period for arsenic sample collection;
- 2) Scrubber water was recycled without addition of make-up water during the entire emission sampling period for K102 waste.

#### 5.0 CONTINUOUS EMISSIONS MONITORING

Continuous emission monitoring was performed at the afterburner outlet location for  $\text{O}_2$ ,  $\text{CO}_2$ , CO, and total hydrocarbons (THC). The sampling location is shown on Figure 1-2. The continuous monitoring was performed for the duration of the test burns of K102 waste and K101 waste. The primary intent of continuous monitoring was to: 1) observe fluctuations in flue gas parameters, and 2) provide documentation of combustion conditions.



Sample acquisition was accomplished using an in-stack ceramic probe filtered with an out-of-stack Balstron filter. The sample was transported to the mobile laboratory using a heated Teflon<sup>R</sup> sample line, maintained at a temperature >120°C. Flue gas analyzed for O<sub>2</sub>, CO<sub>2</sub>, and CO was first pumped through a sample conditioner to knock out moisture, providing analysis on a dry basis. A separate, unconditioned gas sample was supplied to the THC analyzer for wet basis analysis. The concentrations were continuously recorded on stripcharts.

The following instruments were used to analyze for CO, CO<sub>2</sub>, O<sub>2</sub>, and THC:

Carbon Monoxide (CO) Concentration	Beckman Model 865 Infrared Analyzer; Range 0-500 ppm
Carbon Dioxide (CO <sub>2</sub> ) Concentration	Beckman Model 865 Infrared Analyzer; Range 0-20%
Oxygen (O <sub>2</sub> ) Concentration	Thermox WDG AMETEK; Range 0-25%
Total Hydrocarbon (THC) Concentration	Beckman Model 402 Flame Ionization Detector Range 0-100 ppm

Copies of all continuous emission data were given to the EPA work assignment manager, Mr. Juan Baez-Martinez, prior to leaving the test site.

TABLE 3-1. SUMMARY OF RESULTS OF ARSENIC EMISSIONS SAMPLING

Sample	% O <sub>2</sub>	% H <sub>2</sub> O	Arsenic Emissions					
			Flow		Total Arsenic		Arsenic Emissions	
			ACFM	DSCFM	#/hr	kg/hr	As #/hr	As <sub>2</sub> O <sub>3</sub> kg/hr
1	6.1	53.7	1686	630	.0111	.0050	.0147	.0067
2	6.1	56.0	1736	615	.0181	.0082	.0239	.0108
3	5.7	55.5	1695	060	.0231	.0105	.0305	.0139

## APPENDIX

**RADIAN SOURCE TEST  
EPA METHOD 2-5\*  
(RAW DATA)**

PLANT : JOHN ZINK  
PLANT SITE : TULSA , OK  
SAMPLING LOCATION : SCRUBBER OUTLET  
TEST # : BDAT-JZ-1201-AS-01  
DATE : 12/01/87  
TEST PERIOD : 1725-1830

PARAMETER -----	VALUE -----
Sampling time (min.)	60
Barometric Pressure (in.Hg)	29.57
Sampling nozzle diameter (in.)	.376
Meter Volume (cu.ft.)	36.337
Meter Pressure (in.H2O)	1.225
Meter Temperature (F)	74.83335
Stack dimension (sq.in.)	113.0976
Stack Static Pressure (in.H2O)	1.4
Stack Moisture Collected (gm)	378.2
Absolute stack pressure(in Hg)	29.67294
Average stack temperature (F)	189.0833
Percent CO2	8.5
Percent O2	6.1
Percent N2,	85.4
Delp's Subroutine result	13.12519
DGM Factor	1.0051
Pitot Constant	.84

\* Although Method 108 was used for arsenic sampling, EPA Methods 2-5 were used to calculate gas flow and emission rates as shown in the sample calculations to follow.

# RADIANT SOURCE TEST EPA METHODS 2-5 FINAL RESULTS

PLANT : JOHN ZINK  
 PLANT SITE : TULSA , OK  
 SAMPLING LOCATION : SCRUBBER OUTLET  
 TEST # : BDAT-JZ-1201-AS-01  
 DATE : 12/01/87  
 TEST PERIOD : 1725-1830

PARAMETER -----	RESULT -----
Vm(dscf)	35.74246
Vm(dscm)	1.012226
Vw gas(sct)	41.40713
Vw gas (scm)	1.17265
% moisture	53.67123
Md	.4632877
MWd	29.504
MW	13.07599
Vs(fpm)	2147.268
Vs (mpm)	654.655
Flow(acfm)	1686.464
Flow(acmm)	47.76067
Flow(dscfm)	630.3191
Flow(dscmm)	17.85064
% I	96.31988
% EA	37.09199

Program Revision:1/16/84

**RADIAN SOURCE TEST  
EPA METHOD 5  
PARTICULATE LOADING**

PLANT : JOHN ZINK  
PLANT SITE : TULSA , OK  
SAMPLING LOCATION : SCRUBBER OUTLET  
TEST # : BDAT-JZ-1201-AS-01  
DATE : 12/01/87  
TEST PERIOD : 1725-1830

PARAMETER -----	FRONT-HALF -----	TRAIN TOTAL (A <sub>3</sub> ) -----	As <sub>2</sub> O <sub>3</sub>
Total Grams	0.0041800	0.0047580	
Grams/dscf	0.0001169	0.0001331	
Grams/acf	0.0000437	0.0000498	
Grains/dscf	0.0018045	0.0020540	
Grains/acf	0.0006744	0.0007677	
Grams/dscm	0.0041294	0.0047004	
Grams/acm	0.0015434	0.0017368	
Pounds/dscf	0.0000003	0.0000003	
Pounds/acf	0.0000001	0.0000001	
Pounds/Hr	0.0097524	0.0111010	.0147
Kilograms/Hr	0.0044237	0.0050354	.0067

Program Revision: 1/16/84

RADIANT SOURCE TEST  
EPA METHOD 2-5  
(RAW DATA)

PLANT : JOHN ZINK  
PLANT SITE : TULSA , OK  
SAMPLING LOCATION : SCRUBBER OUTLET  
TEST # : BDAT-JZ-1201-AS-02  
DATE : 12/01/87  
TEST PERIOD : 1802-1905

PARAMETER -----	VALUE -----
Sampling time (min.)	60
Barometric Pressure (in.Hg)	29.57
Sampling nozzle diameter (in.)	.375
Meter Volume (cu.ft.)	57
Meter Pressure (in.H2O)	1.575
Meter Temperature (F)	81.95855
stack dimension (sq.in.)	113.0776
Stack Static Pressure (in.H2O)	1.4
Stack Moisture Collected (gm)	968.9
Absolute stack pressure(in Hg)	29.67294
Average stack temperature (F)	191.25
Percent CO2	8.5
Percent O2	6.1
Percent N2	85.4
Delps Subroutine result	13.43468
DGM Factor	1.0056
Pitot Constant	.84

# RADIAN SOURCE TEST EPA METHODS 2-5 FINAL RESULTS

PLANT : JOHN ZINK  
PLANT SITE : FULSA , OK  
SAMPLING LOCATION : SCRUBBER OUTLET  
TEST # : BDAT-JZ-1201-AS-02  
DATE : 12/01/87  
TEST PERIOD : 1802-1905

PARAMETER -----	RESULT -----
Vm(dscf)	35.94737
Vm(dscm)	1.018029
Vw gas(scf)	45.68364
Vw gas (scm)	1.293761
% moisture	55.96358
Md	.4403642
MWd	19.204
MW	23.10999
Vs(tpm)	2210.513
Vs (mpm)	673.9369
Flow(actm)	1736.137
Flow(acmm)	49.1674
Flow(dscfm)	614.7254
Flow(dscmm)	17.40902
% I	99.85988
% EA	37.09199

Program Revision:1/16/84



RADIAN SOURCE TEST  
EPA METHOD 5  
PARTICULATE LOADING

PLANT : JOHN ZINK  
PLANT SITE : TULSA , OK  
SAMPLING LOCATION : SCRUBBER OUTLET  
TEST # : BDAT-JZ-1201-AS-02  
DATE : 12/01/87  
TEST PERIOD : 1802-1905

PARAMETER -----	FRONT-HALF -----	TRAIN TOTAL (As) -----	(As <sub>2</sub> O <sub>3</sub> )
Total Grams	0.0073000	0.0079850	
Grams/dscf	0.0002031	0.0002221	
Grams/act	0.0000719	0.0000787	
Grains/dscf	0.0031334	0.0034275	
Grains/act	0.0011095	0.0012136	
Grams/dscm	0.0071706	0.0078434	
Grams/acm	0.0025389	0.0027772	
Pounds/dscf	0.0000004	0.0000005	
Pounds/act	0.0000002	0.0000002	
Pounds/Hr	0.0165157	0.0180635	.0239
Kilograms/Hr	0.0074915	0.0081944	.0108

Program Revision: 1/16/84

RADIAN SOURCE TEST  
EPA METHOD 2-5  
(RAW DATA)

PLANT : JOHN ZINK  
PLANT SITE : TULSA , OK  
SAMPLING LOCATION : SCRUBBER OUTLET  
TEST # : BDAT-JZ-1201-AS-03  
DATE : 12/01/87  
TEST PERIOD : 1920-2024

PARAMETER -----	VALUE -----
Sampling time (min.)	60
Barometric Pressure (in.Hg)	29.57
Sampling nozzle diameter (in.)	.376
Meter Volume (cu.ft.)	35.998
Meter Pressure (in.H2O)	1.220833
Meter Temperature (F)	71.70835
Stack dimension (sq.in.)	113.0976
Stack Static Pressure (in.H2O)	1.3
Stack Moisture Collected (gm)	942.8
Absolute stack pressure(in Hg)	29.66559
Average stack temperature (F)	190.75
Percent CO2	10.3
Percent O2	5.7
Percent N2	84
Delp's Subroutine result	13.16211
DGM Factor	1.0051
Pitot Constant	.84

# RADIAN SOURCE TEST EPA METHODS 2-5 FINAL RESULTS

PLANT : JOHN ZINK  
PLANT SITE : TULSA , OK  
SAMPLING LOCATION : SCRUBBER OUTLET  
TEST # : BDAT-JZ-1201-AS-03  
DATE : 12/01/87  
TEST PERIOD : 1920-2024

PARAMETER -----	RESULT -----
Vm(dscf)	35.61675
Vm(dscm)	1.008666
Vw gas(scft)	44.45302
Vw gas (scm)	1.25891
% moisture	55.51786
Md	.4448215
MWd	29.676
MW	23.2827
Vs (tpm)	2157.885
Vs (mpm)	657.8918
Flow(acfm)	1694.803
Flow(acmm)	47.99681
Flow(dscfm)	606.4793
Flow(dscmm)	17.17549
% I	99.75398
% EA	34.59577

Program Revision:1/16/84

RADIANT SOURCE TEST  
EPA METHOD 5  
PARTICULATE LOADING

PLANT : JOHN ZINK  
PLANT SITE : TULSA , OK  
SAMPLING LOCATION : SCRUBBER OUTLET  
TEST # : BDAT-JZ-1201-AS-03  
DATE : 12/01/87  
TEST PERIOD : 1920-2024

PARAMETER -----	FRONT-HALF -----	RAIN TOTAL (As) -----	(As <sub>2</sub> O <sub>3</sub> )
Total Grams	0.0085000	0.0102700	
Grams/dscf	0.0002387	0.0002883	
Grams/acf	0.0000854	0.0001032	
Grains/dscf	0.0036824	0.0044492	
Grains/acf	0.0015177	0.0015921	
Grams/dscm	0.0084268	0.0101816	
Grams/acm	0.0030155	0.0036434	
Pounds/dscf	0.0000005	0.0000006	
Pounds/acf	0.0000002	0.0000002	
Pounds/Hr	0.0191488	0.0231362	.0305
Kilograms/Hr	0.0086858	0.0104945	.039

Program Revision: 1/16/84

# RADIAN SOURCE TEST EPA METHOD 2-5 SAMPLE CALCULATION

PLANT : JOHN ZINK  
PLANT SITE : TULSA , OK  
SAMPLING LOCATION : SCRUBBER OUTLET  
TEST # : BDAT-JZ-1201-AS-03  
DATE : 12/01/87  
TEST PERIOD : 1920-2024

1) Volume of dry gas sampled at standard conditions (68 deg-F ,29.92 in. Hg).

$$Vm(std) = \frac{Y \times Vm \times [T(std) + 460] \times [Pb + (Pm/13.6)]}{P(std) \times (Vm + 460)}$$

$$Vm(std) = \frac{1.0051 \times 15.998 \times 528 \times (29.57 + 460) \times (1.220673 + 13.6)}{29.92 \times (71.70835 + 460)}$$

$$Vm(std) = 35.617dscf$$

Volume of water vapor at standard conditions:

$$Vw(gas) = 0.04715 \text{ cf/gm} \times W(l) \text{ gm}$$

$$Vw(gas) = 0.04715 \times 942.8 = 44.453 \text{ scf}$$

3) Percent Moisture in stack gas :

$$\%M = \frac{100 \times Vw(gas)}{Vm(std) + Vw(gas)}$$

$$\%M = \frac{100 \times 44.453}{35.617 + 44.453} = 55.52 \%$$

4) Mole fraction of dry stack gas :

$$Md = \frac{100 - \%M}{100} = \frac{100 - 55.52}{100} = .4448215$$

# SAMPLE CALCULATION PAGE TWO

5) Average Molecular Weight of DRY stack gas :

$$MWd = (.44 \times \%CO_2) + (.32 \times \%O_2) + (.28 \times \%N_2)$$

$$MWd = (.44 \times 10.3) + (.32 \times 5.7) + (.28 \times 84) = 29.876$$

6) Average Molecular Weight of wet stack gas :

$$MW = MWd \times Md + 18(1 - Md)$$

$$MW = 29.876 \times .4448215 + 18(1 - .4448215) = 23.2827$$

7) stack gas velocity in feet-per-minute (fpm) at stack conditions :

$$Vs = Kp \times Cp \times [SQRT(dP)]^{ave} \times SQRT[Ts]^{avg} \times SQRT[1/(Ps \times MW)] \times 60 \text{ sec/min}$$

$$Vs = 85.49 \times .84 \times 60 \times 13.16211 \times SQRT[1/(29.66559 \times 23.2827)]$$

$$Vs = 2157.885 \text{ FPM}$$

8) Average stack gas dry volumetric flow rate (DSCFM) :

$$Qsd = \frac{Vs \times As \times Md \times T(std) \times Ps}{144 \text{ cu.in./cu.ft.} \times (Ts + 460) \times P(std)}$$

$$Qsd = \frac{2157.885 \times 113.0976 \times .4448215 \times 528 \times 29.66559}{144 \times 650.75 \times 29.92}$$

$$Qsd = 606.4793 \text{ dscfm}$$

## SAMPLE CALCULATION

Isokinetic sampling rate (%):

$$\text{Dimensional Constant } C = K_4 \times 144 \times [1/(pI/4)]$$

$$k_4 = .0945 \text{ For English Units}$$

$$I\% = \frac{C \times V_m(\text{std}) \times (T_s + 460)}{V_s \times T_t \times P_s \times M_d \times (D_n)^2}$$

$$I\% = \frac{1039.574 \times 35.61675 \times 650.75}{2157.885 \times 60 \times 29.66559 \times .4448215 \times (.376)^2}$$

$$I\% = 99.75398$$

Excess air (%):

$$EA = \frac{100 \times \%O_2}{(.264 \times \%N_2) - \%O_2} - \frac{100 \times 5.7}{(.264 \times 84) - 5.7}$$

$$EA = 34.60$$

Particulate concentration:

$$C_s = (\text{grams As}) / V_m(\text{std}) = .01027 / 35.61675$$

$$C_s = 0.0002883 \text{ Grams/DSCF}$$

$$C_a = \frac{T(\text{std}) \times M_d \times P_s \times C_s}{P(\text{std}) \times T_s}$$

$$C_a = \frac{528 \times .4448215 \times 29.66559 \times 0.0002883}{29.92 \times 650.75}$$

$$C_a = 0.0001032 \text{ Grams/ACF}$$

$$16 \text{ As/hr} = C_s \times 0.002205 \times Q_{sd} \times 60$$

$$16 \text{ As/hr} = 0.002883 \times 0.002205 \times 606.5 \times 60$$

$$16 \text{ As/hr} = .0231362$$

$$16 \text{ As}_2\text{O}_3 = \frac{16 \text{ As}}{\text{hr}} \times \frac{16 \text{ mole As}}{16 \text{ As}} \times \frac{16 \text{ mole As}_2\text{O}_3}{2 \times 16 \text{ mole As}} \times \frac{16 \text{ As}_2\text{O}_3}{16 \text{ mole As}_2\text{O}_3}$$

$$16 \text{ As}_2\text{O}_3 = \frac{0.0231362 \times 197.84}{74.92 \times 2}$$

$$16 \text{ As}_2\text{O}_3 = 0.0305$$

# RADIAN SOURCE TEST EPA METHODS 2-5 DEFINITION OF TERMS

PARAMETER -----	DEFINITION -----
Tt(min.)	TOTAL SAMPLING TIME
Dn(in.)	SAMPLING NOZZLE DIAMETER
Ps(in.H2O)	ABSOLUTE STACK STATIC GAS PRESSURE
Vm(cu.ft.)	ABSOLUTE VOLUME OF GAS SAMPLE MEASURED BY DGM
Vw(gm.)	TOTAL STACK MOISTURE COLLECTED
Pm(in.H2O)	AVERAGE STATIC PRESSURE OF DGM
Tm(F)	AVERAGE TEMPERATURE OF DGM
Pb(in.Hg.)	BAROMETRIC PRESSURE
% CO2	CARBON DIOXIDE CONTENT OF STACK GAS
% O2	OXYGEN CONTENT OF STACK GAS
% N2	NITROGEN CONTENT OF STACK GAS
SQR(DELPS)	AVE. SQ. ROOT OF S-PITOT DIFF. PRESSURE-TEMP. PRODUCTS
As(sq.in.)	CROSS-SECTIONAL AREA OF STACK(DUCT)
ts(F)	TEMPERATURE OF STACK
Vm(dscf)	STANDARD VOLUME OF GAS SAMPLED ,Vm(std),AS DRY STD. CF
Vm(dscm)	STANDARD VOLUME OF GAS SAMPLED,Vm(std),AS DRY STD. CM
Vw gas(scft)	VOLUME OF WATER VAPOR IN GAS SAMPLE,STD
% moisture	WATER VAPOR COMPOSITION OF STACK GAS
Md	PROPORTION, BY VOLUME,OF DRY GAS IN GAS SAMPLE
MWd	MOLECULAR WEIGHT OF STACK GAS,DRY BASIS LB/LB-MOLE
MW	MOLECULAR WEIGHT OF STACK GAS,WET BASIC LB/LB-MOLE
Vs(tpm)	AVERAGE STACK GAS VELOCITY
Flow(acfm)	AVERAGE STACK GAS FLOW RATE(ACTUAL STACK COND.)
Flow(acmm)	AVERAGE STACK GAS FLOW RATE(ACTUAL STACK COND.)
Flow(dscfm)	AVERAGE STACK GAS VOLUMETRIC FLOW RATE(DRY BASIS)
Flow(dscmm)	AVERAGE STACK GAS VOLUMETRIC FLOW RATE(DRY BASIS)
% i	PERCENT ISOKINETIC
% EA	PERCENT EXCESS AIR IN STACK GAS
DGM	DRY GAS METER
Y	DRY GAS METER CORRECTION FACTOR
Pg	STACK STATIC GAS PRESSURE
Cp	PITOT COEFFICIENT
dH	ORIFICE PLATE DIFF. PRESS. VALUE
dP	PITOT DIFF. PRESS. VALUE

\*\*\* EPA  
STANDARD  
CONDITIONS

Temperature = 68 deg-F (528 deg-R)  
Pressure = 29.92 in. Hg.



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SPRINGFIELD VA 22151

REPORT NUMBER: L002008

SAMPLE IDENTIFICATION: 2380-01  
CUSTOMER IDENTIFICATION: JZ-01 & -02  
DATE SAMPLED: 12/01/87  
TYPE OF MATERIAL: FILTER/LIQ

DATE RECEIVED: 12/02/87  
DATE COMPLETED: 12/03/87

PARAMETER	REF. METHOD	DETL. LIMIT	RESULT
ARSENIC (T)	100	2 UG	4180 UG
FINAL WEIGHT OF FILTER	-----	0.0001 GRAMS	0.0015 GRAMS

BDL = BELOW DETECTION LIMIT

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REPORT NUMBER: L002008

PAGE 2

SAMPLE IDENTIFICATION: 3380-02  
CUSTOMER IDENTIFICATION: JZ-03 & -04  
DATE SAMPLED: 12/01/87  
TYPE OF MATERIAL: LIQUID

DATE RECEIVED: 12/02/87  
DATE COMPLETED: 12/03/87

PARAMETER	REF. METHOD	DET. LIMIT	RESULT
ARSENIC (T)	103	2 UG	578 UG

BDL = BELOW DETECTION LIMIT

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REPORT NUMBER: L002008

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SAMPLE IDENTIFICATION: 2380-03  
CUSTOMER IDENTIFICATION: JZ-05 & -06  
DATE SAMPLED: 12/01/87  
TYPE OF MATERIAL: FILTER/LIQ

DATE RECEIVED: 12/02/87  
DATE COMPLETED: 12/03/87

PARAMETER	REF. METHOD	DET. LIMIT	RESULT
ARSENIC (T)	108	2 UG	7300 UG
FINAL WEIGHT OF FILTER	----	0.0001 GRAMS	0.7254 GRAMS

BUL = BELOW DETECTION LIMIT

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REPORT NUMBER: L002008

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SAMPLE IDENTIFICATION: 2380-04  
CUSTOMER IDENTIFICATION: JZ-07 & -08  
DATE SAMPLED: 12/01/87  
TYPE OF MATERIAL: LIQUID

DATE RECEIVED: 12/02/87  
DATE COMPLETED: 12/03/87

PARAMETER	SEE METHOD	DETECT LIMIT	RESULT
ARSENIC (T)	108	2 UG	685 UG

BOL = BELOW DETECTION LIMIT

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REPORT NUMBER: L002008

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SAMPLE IDENTIFICATION: 2380-05  
CUSTOMER IDENTIFICATION: JZ-09 & -10  
DATE SAMPLED: 12/01/87  
TYPE OF MATERIAL: FILTER/LIQ

DATE RECEIVED: 12/02/87  
DATE COMPLETED: 12/03/87

PARAMETER	SEE METHOD	DET. LIMIT	RESULT
ARSENIC (Y)	108	0 UG	8500 UG
FINAL WEIGHT OF FILTER	----	0.0001 GRAMS	0.3243 GRAMS

BDL = BELOW DETECTION LIMIT

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SAMPLE IDENTIFICATION: 2380-06  
CUSTOMER IDENTIFICATION: JZ-11 & -12  
DATE SAMPLED: 12/01/87  
TYPE OF MATERIAL: LIQUID

DATE RECEIVED: 12/02/87  
DATE COMPLETED: 12/03/87

PARAMETER	REF. METHOD	DET. LIMIT	RESULT
ARSENIC (P)	108	2 UG	1770 UG

BDL = BELOW DETECTION LIMIT

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REPORT NUMBER: L002008

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SAMPLE IDENTIFICATION: 2380-07  
CUSTOMER IDENTIFICATION: JZ-13 H2O BLANK  
DATE SAMPLED: 12/01/87  
TYPE OF MATERIAL: LIQUID

DATE RECEIVED: 12/02/87  
DATE COMPLETED: 12/03/87

PARAMETER	REF. METHOD	DET. LIMIT	RESULT
ARSENIC (T)	106	2 UG	BDL UG

BDL = BELOW DETECTION LIMIT

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REPORT NUMBER: L002008

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SAMPLE IDENTIFICATION: 2380-08  
CUSTOMER IDENTIFICATION: JZ-14 NAOH BLANK  
DATE SAMPLED: 12/01/87  
TYPE OF MATERIAL: LIQUID

DATE RECEIVED: 12/02/87  
DATE COMPLETED: 12/03/87

PARAMETER	REF. METHOD	DET. LIMIT	RESULT
ARSENIC (T)	100	2 UG	BDL UG

BELOW DETECTION LIMIT



Date (DDMMYY): 11/30/87

Initials of Calibrator: JBC

Nozzle Identification No.	D <sub>1</sub> (inches)	D <sub>2</sub> (inches)	D <sub>3</sub> (inches)	Average Diameter (inches)
A-1	.187 <u>D<sub>4</sub></u> .185	.186 <u>D<sub>5</sub></u> .187	.186 <u>D<sub>6</sub></u> .188	.187
A-2	.252 <u>D<sub>4</sub></u> .251	.251 <u>D<sub>5</sub></u> .253	.253 <u>D<sub>6</sub></u> .255	.253 <del>.255</del>
A-3	.309 <u>D<sub>4</sub></u> .313	.312 <u>D<sub>5</sub></u> .312	.312 <u>D<sub>6</sub></u> .313	.312
A-4	.376 .377	.374 .376	.375 .376	.376

Note: The maximum acceptable difference between any two measurements is 0.004 inches. If this tolerance cannot be met, the nozzle should not be used.

Figure 5-2. Nozzle calibration sheet.

Date (DDMMYY): 11/30/87

Initials of Calibrator: BC

Nozzle Identification No.	D <sub>1</sub> (inches)	D <sub>2</sub> (inches)	D <sub>3</sub> (inches)	Average Diameter (inches)
B-1	.186 <u>D<sub>4</sub></u> .187	.185 <u>D<sub>5</sub></u> .188	.187 <u>D<sub>6</sub></u> .186	.187
B-2	.252 .254	.252 <del>.247</del> .252	.251 .252	.252
B-3	.302 .302	.301 .302	.303 .303	.302
B-4	.373 .374	.375 .375	.374 .375	.375

Note: The maximum acceptable difference between any two measurements is 0.004 inches. If this tolerance cannot be met, the nozzle should not be used.

Figure 5-2. Nozzle calibration sheet.

PLANT John Zink  
DATE 12-1-81  
SAMPLING LOCATION Durbin  
SAMPLE TYPE AS  
RUN NUMBER SDAT-JZ-1201-AS-01  
OPERATOR DZ  
AMBIENT TEMPERATURE 10  
BAROMETRIC PRESSURE 29.57  
STATIC PRESSURE (P<sub>s</sub>) 11.4  
FILTER NUMBER (sf) \_\_\_\_\_

PROBE LENGTH AND TYPE 2 2105  
NOZZLE I.D. 374 718714  
ASSUMED MOISTURE, % 56  
SAMPLE BOX NUMBER \_\_\_\_\_  
METER BOX NUMBER 1  
METER AM. 1.83  
C FACTOR 4.7  
PROBE HEATER SETTING 248125  
HEATER BOX SETTING 248125  
REFERENCE AM. \_\_\_\_\_  
METER V 1.0051

K-4.

# KADIAN

SCHEMATIC OF TRAVERSE POINT LAYOUT  
READ AND RECORD ALL DATA EVERY 5 MINUTES

[illegible]

**COMMENTS:**

PLANT John Zink  
DATE 11/30/87  
SAMPLING LOCATION Scrubber Out  
SAMPLE TYPE Arsenic  
RUN NUMBER BNAT-52-1201-A5-02  
SAMPLE BOX NUMBER \_\_\_\_\_  
CLEAN-UP PERSON Doerle  
SOLVENT RINGS 0.1N NaOH

## CONTENTS.

**FRONT HALF - ARTICULATE PHASE**

SOLVENT WASH OF NOZZLE, PROBE, CYCLONE (BYPASS).  
FLASK, FRONT HALF OF FILTER HOLDER

**CONTAINER 2**

### GRAVIMETRIC RESULTS

FINAL:-

**TARE:** \_\_\_\_\_

NET.

LABORATORY RESULTS

F<sup>1</sup>/<sub>2</sub> Rinse 231.7 ml

CONTAINER #

**FINAL:** \_\_\_\_\_

TARE: 0.0000

NET.

FRONT HALF SUBTOTAL

**ORGANIC-VAPOR PHASE**

TRANSFER LINE AND CONDENSER  
(SOLVENT RINSE)

**Abstract**

**RESIN TRAP (LAC-2)**  
(NOTE): CAP & LABEL IMMEDIATELY

B<sup>1/2</sup> ~~was~~ 27.5 ml NaOH  
Filter holder

INPINGER NO. 1 (QA)

CONTAINER NO.

NET GAIN  
(See Impinger Results  
Reverse Side)

TOTAL

## NOTES/OBSERVATIONS

Impinger No.	Solution Used	Amount of Solution (ml)	Imp. Tip Configuration
1 <sup>st</sup>	Empty	0	K.O.
2	H <sub>2</sub> O	~ 120 ml	modified
3	H <sub>2</sub> O	~ 110 ml	G.S.
4	empty	0	modified
5	Silica Gel	~ 250 g	modified
6			
7			

Weight (grams)

Final	132.0
Initial	458.1
Wt. gain	273.3
Final	912.4
Initial	640.2
Wt. gain	272.2
Final	928.9
Initial	618.5
Wt. gain	310.9
Final	550.6
Initial	282.3
Wt. gain	268.3
Final	740.0
Initial	695.5
Wt. gain	74.1
Final	
Initial	
Wt. gain	
Final	
Initial	
Wt. gain	

TOTAL WEIGHT GAIN OF FINGERS (grams) 968.90

\*OA SAMPLE FOR ORGANIC COLLECTION EFFICIENCY - SAVE IN CONTAINER #4.

**Samples for Further Analysis:**

[illegible]

PLANT Schm 2 Int  
 DATE 12-1-87  
 SAMPLING LOCATION Outlet  
 SAMPLE TYPE AS  
 RUN NUMBER 3041-52-1201-AS-02  
 OPERATOR Doerflinger  
 AMBIENT TEMPERATURE 60  
 BAROMETRIC PRESSURE 29.57  
 STATIC PRESSURE (P<sub>s</sub>) +14  
 FILTER NUMBER (a) \_\_\_\_\_

PROBE LENGTH AND TYPE 2' glass  
 NOZZLE I.D. .375  
 ASSUMED MOISTURE, % 56  
 SAMPLE BOX NUMBER \_\_\_\_\_  
 METER BOX NUMBER 7  
 METER AM 196  
 C FACTOR 5  
 PROBE HEATER SETTING 248±25  
 HEATER BOX SETTING 248±25  
 REFERENCE ap  
 METER 1.00576

SCHEMATIC OF TRAVERSE POINT LAYOUT  
 READ AND RECORD ALL DATA EVERY 5 MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V <sub>m</sub> ), ft <sup>3</sup>	VELOCITY HEAD (h <sub>v</sub> ), in. H <sub>2</sub> O	ORIFICE PRESSURE DIFFERENTIAL (h <sub>o</sub> ), in. H <sub>2</sub> O		STACK TEMPERATURE (T <sub>s</sub> ), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	WIPER TEMPERATURE, °F
					DESIRED	ACTUAL		INLET (T <sub>m in</sub> ), °F	OUTLET (T <sub>m out</sub> ), °F			
		<u>1802</u>	<u>81.000</u>									
A-4	5	<u>1807</u>	<u>84.00</u>	<u>.29</u>	<u>1.4</u>	<u>1.4</u>	<u>193</u>	<u>77</u>	<u>74</u>	<u>6</u>	<u>250</u>	<u>50</u>
	10	<u>1812</u>	<u>87.09</u>	<u>.27</u>	<u>1.4</u>	<u>1.4</u>	<u>194</u>	<u>79</u>	<u>75</u>	<u>6</u>	<u>254</u>	<u>52</u>
	15	<u>1817</u>	<u>91.34</u>	<u>.28</u>	<u>1.4</u>	<u>1.4</u>	<u>194</u>	<u>80</u>	<u>74</u>	<u>8</u>	<u>269</u>	<u>47</u>
	20	<u>1822</u>	<u>93.29</u>	<u>.27</u>	<u>1.3</u>	<u>1.3</u>	<u>194</u>	<u>88</u>	<u>74</u>	<u>6</u>	<u>274</u>	<u>45</u>
	25	<u>1827</u>	<u>96.75</u>	<u>.32</u>	<u>1.4</u>	<u>1.4</u>	<u>193</u>	<u>90</u>	<u>74</u>	<u>7</u>	<u>276</u>	<u>47</u>
	30	<u>1832</u>	<u>99.70</u>	<u>.27</u>	<u>1.3</u>	<u>1.3</u>	<u>193</u>	<u>94</u>	<u>75</u>	<u>7</u>	<u>268</u>	<u>48</u>
	35	<u>1835</u>	<u>99.70</u>									
B-1	5	<u>1840</u>	<u>102.90</u>	<u>.30</u>	<u>1.5</u>	<u>1.5</u>	<u>192</u>	<u>88</u>	<u>76</u>	<u>6</u>	<u>273</u>	<u>61</u>
	10	<u>1845</u>	<u>106.09</u>	<u>.30</u>	<u>1.5</u>	<u>1.5</u>	<u>193</u>	<u>92</u>	<u>77</u>	<u>6</u>	<u>261</u>	<u>56</u>
	15	<u>1850</u>	<u>109.09</u>	<u>.24</u>	<u>1.3</u>	<u>1.3</u>	<u>185</u>	<u>93</u>	<u>77</u>	<u>4</u>	<u>266</u>	<u>53</u>
	20	<u>1855</u>	<u>112.10</u>	<u>.24</u>	<u>1.3</u>	<u>1.3</u>	<u>185</u>	<u>93</u>	<u>77</u>	<u>4</u>	<u>256</u>	<u>48</u>
	25	<u>1860</u>	<u>115.16</u>	<u>.26</u>	<u>1.3</u>	<u>1.3</u>	<u>186</u>	<u>92</u>	<u>76</u>	<u>4</u>	<u>258</u>	<u>48</u>
	30	<u>1865</u>	<u>118.000</u>	<u>.25</u>	<u>1.3</u>	<u>1.3</u>	<u>193</u>	<u>92</u>	<u>75</u>	<u>4</u>	<u>256</u>	<u>49</u>
		<u>1905</u>										
			<u>LEAK V = 0.004 @ 10"</u>									
			<u>37.00</u>				<u>191</u>	<u>82</u>				

COMMENTS

PLANT John Zink  
DATE 11/30/87  
SAMPLING LOCATION Scrubber Out.  
SAMPLE TYPE Arsenic  
BIN NUMBER ~~IS~~ BAT-JZ-1201-As-O1  
SAMPLE BOX NUMBER \_\_\_\_\_  
CLEAN-UP PERSON J Doerle  
SOLVENT RINSES DIN NaOH

FRONT HALF - PARTICULATE PHASE

SOLVENT WASH OF NOZZLE, PROBE, CYCLONE (BYPASS),  
FLASK, FRONT HALF OF FILTER HOLDER

$$F/2 \text{ NaOH} = 227.1 \text{ mL}$$

Filter(q) \_\_\_\_\_

### GRAVIMETRIC RESULTS

**FINAL:-**

**TARE:** \_\_\_\_\_

REF: \_\_\_\_\_

FINAL.

TARE \_\_\_\_\_

NET

### LABORATORY RESULTS

FRONT HALF SUBTOTAL

ORGANIC-VAPOR PHASE

TRANSFER LINE AND CONDENSER  
(SOLVENT RINSE)

CONTAINER, JZ-04

RESIN TRAY (XAG-2) Filter holder  
(NOTE): CAP & LABEL IMMEDIATELY 3 1/2 rinse.

~~\_\_\_\_\_~~ 29.3 ml

(REF ID: A66044)

CONTAINER 24

NET GAIN  
(See Impinger Results  
Reverse Side)

**TOTAL** \_\_\_\_\_

## NOTES/OBSERVATIONS

Rinses  
mL N:OH  
2nd

Impinger No	Solution Used	Amount of Solution (ml)	Imp. Tip Configuration
1	Empty	0	K.C.
2	H <sub>2</sub> O	~100 ml	modified
3	H <sub>2</sub> C	~110 ml	C.S.
4	empty	0	modified
5	Silica gel	250g	modified
6			
7			

Weight (grams)	
Final	635.6
Initial	492.6
Wt. gain	143.0
Final	905.5
Initial	600.0
Wt. gain	305.5
Final	850.3
Initial	563.2
Wt. gain	287.1
Final	546.9
Initial	471.2
Wt. gain	75.7
Final	751.7
Initial	710.8
Wt. gain	40.9
Final	
Initial	
Wt. gain	
Final	
Initial	
Wt. gain	

TOTAL WEIGHT GAIN OF IMPINGERS (grams)

878.20

\*ON SAMPLE FOR ORGANIC COLLECTION EFFICIENCY - SAVE IN CONTAINER #4.

**Samples for Further Analysis:**

Sample No	Description	Species	Results (Total mg )
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

# DRY MOLECULAR WEIGHT DETERMINATION

PLANT John Fend  
 DATE 1 Dec 87  
 SAMPLING TIME (24-hr CLOCK) \_\_\_\_\_  
 SAMPLING LOCATION OUTLET  
 SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS) INTEGRATED  
 ANALYTICAL METHOD OBSAT  
 AMBIENT TEMPERATURE \_\_\_\_\_  
 OPERATOR JBC

COMMENTS: Taken during 1st M108 (As) Run

RUN GAS	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M <sub>d</sub> , lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO <sub>2</sub>	8.4	8.4	8.5	8.5			8.5	44/100	
O <sub>2</sub> (NET IS ACTUAL O <sub>2</sub> READING MINUS ACTUAL CO <sub>2</sub> READING)	14.5	6.1	14.5	6.0			6.1	32/100	
CO (NET IS ACTUAL CO READING MINUS ACTUAL O <sub>2</sub> READING)								28/100	
N <sub>2</sub> (NET IS 100 MINUS ACTUAL CO READING)								28/100	
TOTAL								29.60	

PLANT T. J. Zink  
DATE 12-01-87  
SAMPLING LOCATION Scrubber Out  
SAMPLE TYPE AS  
RUN NUMBER BOAT-12-1201-AS-03  
OPERATOR Doerle  
AMBIENT TEMPERATURE 40  
BAROMETRIC PRESSURE 29.57  
STATIC PRESSURE (P<sub>s</sub>) 1.3  
FILTER NUMBER (H) NA

PROBE LENGTH AND TYPE 2' glass  
NOZZLE I.D. 376 #8414 RO  
ASSUMED MOISTURE, % 56  
SAMPLE BOX NUMBER \_\_\_\_\_  
METER BOX NUMBER \_\_\_\_\_  
METER AM 1.83  
C FACTOR 4.7  
PROBE HEATER SETTING 2481-25  
HEATER BOX SETTING 2481-25  
REFERENCE AP \_\_\_\_\_  
METER Y 1.0051

SCHEMATIC OF TRAVERSE POINT LAYOUT  
READ AND RECORD ALL DATA EVERY 2 MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V <sub>m</sub> , ft <sup>3</sup> )	VELOCITY HEAD (h <sub>v</sub> , in. H <sub>2</sub> O)	ORIFICE PRESSURE DIFFERENTIAL (h <sub>o</sub> , in. H <sub>2</sub> O)		STACK TEMPERATURE (T <sub>s</sub> , °F)	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPIGGER TEMPERATURE, °F
					DESIRED	ACTUAL		INLET (T <sub>m</sub> , °F)	OUTLET (T <sub>g</sub> , °F)			
		<u>1920</u>	<u>12.000</u>									
A-1	8	<u>1925</u>	<u>15.05</u>	<u>126</u>	<u>1.2</u>	<u>1.2</u>	<u>188</u>	<u>74</u>	<u>64</u>	<u>2</u>	<u>274</u>	<u>45</u>
2	10	<u>1930</u>	<u>17.76</u>	<u>123</u>	<u>1.05</u>	<u>1.05</u>	<u>190</u>	<u>78</u>	<u>64</u>	<u>2</u>	<u>275</u>	<u>46</u>
3	15	<u>1935</u>	<u>20.66</u>	<u>125</u>	<u>1.1</u>	<u>1.1</u>	<u>191</u>	<u>80</u>	<u>64</u>	<u>3</u>	<u>272</u>	<u>50</u>
4	20	<u>1940</u>	<u>23.65</u>	<u>127</u>	<u>1.2</u>	<u>1.2</u>	<u>192</u>	<u>80</u>	<u>64</u>	<u>3</u>	<u>269</u>	<u>60</u>
5	25	<u>1945</u>	<u>26.75</u>	<u>128</u>	<u>1.3</u>	<u>1.3</u>	<u>191</u>	<u>81</u>	<u>65</u>	<u>4</u>	<u>270</u>	<u>50</u>
6	30	<u>1950</u>	<u>29.740</u>	<u>127</u>	<u>1.2</u>	<u>1.2</u>	<u>190</u>	<u>81</u>	<u>65</u>	<u>3</u>	<u>274</u>	<u>52</u>
		<u>1954</u>	<u>29.740</u>									
B-1	35	<u>1959</u>	<u>33.04</u>	<u>132</u>	<u>1.5</u>	<u>1.5</u>	<u>188</u>	<u>76</u>	<u>65</u>	<u>4</u>	<u>274</u>	<u>52</u>
2	40	<u>2004</u>	<u>36.01</u>	<u>126</u>	<u>1.2</u>	<u>1.2</u>	<u>192</u>	<u>80</u>	<u>64</u>	<u>3</u>	<u>265</u>	<u>45</u>
3	45	<u>2009</u>	<u>38.97</u>	<u>126</u>	<u>1.2</u>	<u>1.2</u>	<u>191</u>	<u>80</u>	<u>64</u>	<u>4</u>	<u>270</u>	<u>44</u>
4	50	<u>2014</u>	<u>42.07</u>	<u>128</u>	<u>1.3</u>	<u>1.3</u>	<u>192</u>	<u>80</u>	<u>64</u>	<u>4</u>	<u>271</u>	<u>42</u>
5	55	<u>2019</u>	<u>45.15</u>	<u>128</u>	<u>1.3</u>	<u>1.3</u>	<u>193</u>	<u>80</u>	<u>64</u>	<u>4</u>	<u>267</u>	<u>41</u>
6	60	<u>2024</u>	<u>47.998</u>	<u>124</u>	<u>1.1</u>	<u>1.1</u>	<u>191</u>	<u>80</u>	<u>64</u>	<u>4</u>	<u>267</u>	<u>41</u>
			<u>LEAK V<sub>g</sub>(H) = 0.002 (4)</u>			<u>8.11</u>						
			<u>55.998</u>			<u>1.2</u>	<u>191</u>	<u>71.7</u>				

COMMENTS

EPA (Rev) 235  
4-77

Source Sampling Field Data



ORGANIC SAMPLING TRAIN RECOVERY SHEET

PLANT John Zink  
DATE 12/01/87  
SAMPLING LOCATION Secomber Out  
SAMPLE TYPE Arsenic  
RUN NUMBER BDAT-JZ-1201-As 03  
SAMPLE BOX NUMBER \_\_\_\_\_  
CLEAN-UP PERSON Dorelle  
SOLVENT RINSES 0.1N NaOH

**COMMENT 3.**

FRONT HALF - PARTICULATE PHASE

SOLVENT WASH OF NOZZLE, PROBE, CYCLONE (BYPASS),  
FLASK, FRONT HALF OF FILTER HOLDER

CONTAINER # \_\_\_\_\_

### GRAVIMETRIC RESULTS

LABORATORY RESULTS

FINAL. \_\_\_\_\_

TAGE: \_\_\_\_\_ 4

NET. 5

\_\_\_\_\_

**FILTER NUMBER** \_\_\_\_\_

CONTAINER 8

FINAL: 5

TARE \_\_\_\_\_ g

MET. 5

1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2194, 2195, 2196, 2197, 2198, 2199, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2208, 2209, 2210, 2211, 2212, 2213, 2214, 2215, 2216, 2217, 2218, 2219, 2220, 2221, 2222, 2223, 2224, 2225, 2226, 2227, 2228, 2229, 2230, 2231, 2232, 2233, 2234, 2235, 2236, 2237, 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2245, 2246, 2247, 2248, 2249, 2250, 2251, 2252, 2253, 2254, 2255, 2256, 2257, 2258, 2259, 2260, 2261, 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2271, 2272, 2273, 2274, 2275, 2276, 2277, 2278, 2279, 2280, 2281, 2282, 2283, 2284, 2285, 2286, 2287, 2288, 2289, 2290, 2291, 2292, 2293, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2364, 2365, 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, 2380, 2381, 2382, 2383, 2384, 2385, 2386, 2387, 2388, 2389, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 2487, 2488, 2489, 2490, 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499, 2500, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515, 2516, 2517, 2518, 2519, 2520, 2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2542, 2543, 2544, 2545, 2546, 2547, 2548, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2559, 2560, 2561, 2562, 2563, 2564, 2565, 2566, 2567, 2568, 2569, 2570, 2571, 2572, 2573, 2574, 2575, 2576, 2577, 2578, 2579, 2580, 2581, 2582, 2583, 2584, 2585, 2586, 2587, 2588, 2589, 2590, 2591, 2592, 2593, 2594, 2595, 2596, 2597, 2598, 2599, 2600, 2601, 2602, 2603, 2604, 2605, 2606, 2607, 2608, 2609, 2610, 2611, 2612, 2613, 2614, 2615, 2616, 2617, 2618, 2619, 2620, 2621, 2622, 2623, 2624, 2625, 2626, 2627, 2628, 2629, 2630, 2631, 2632, 2633, 2634, 2635, 2636, 2637, 2638, 2639, 2640, 2641, 2642, 2643, 2644, 2645, 2646, 2647, 2648, 2649, 2650, 2651, 2652, 2653, 2654, 2655, 2656, 2657, 2658, 2659, 2660, 2661, 2662, 2663, 2664, 2665, 2666, 2667, 2668, 2669, 2670, 2671, 2672, 2673, 2674, 2675, 2676, 2677, 2678, 2679, 26

FRONT HALF SUBTOTAL \_\_\_\_\_

### ORGANIC-VAPOR PHASE

TRANSFER LINE AND CONDENSER  
(SOLVENT RINSE)

CONTAINER # J212

RESIN TRAP (XAG-2)  
(NOTE): CAP & LABEL IMMEDIATELY

B/c F.H. = 26 ml J.Ott

IMPINGER NO. 1 (QA)

CONTAINER 24 \_\_\_\_\_

NET GAIN \_\_\_\_\_  
(See Impinger Results  
Reverse Side)

TOTAL \_\_\_\_\_

## NOTES/OBSERVATIONS.

Impinger No.	Solution Used	Amount of Solution (ml)	Imp. Tip Configuration	Weight (grams)
27.0 + 16.4	Empty	- 0 -	modified	Final 914.4 Initial 470.5 Wt. gain 443.9
29.7 + 30.4	H <sub>2</sub> O	~130 ml	modified	Final 898.7 Initial 601.9 Wt. gain 296.80
23.5 + 34.8	H <sub>2</sub> O	~100 ml	OR 1 G-S modified	Final 739.7 Initial 522.5 Wt. gain 217.20
27.8 + 26.1	empty	- 0 -	modified	Final 483.4 Initial 455.1 Wt. gain 28.30
	Silica Gel	~250 g	modified	Final 691.4 Initial 675.8 Wt. gain 15.60
				Final Initial Wt. gain
				Final Initial Wt. gain

TOTAL WEIGHT GAIN OF TUPINGERS (gms) 942.80

90A SAMPLE FOR ORGANIC COLLECTION EFFICIENCY - SAVE IN CONTAINER 94

**Samples for Further Analysis:**

Sample No	Description	Species	Results (Total mg)

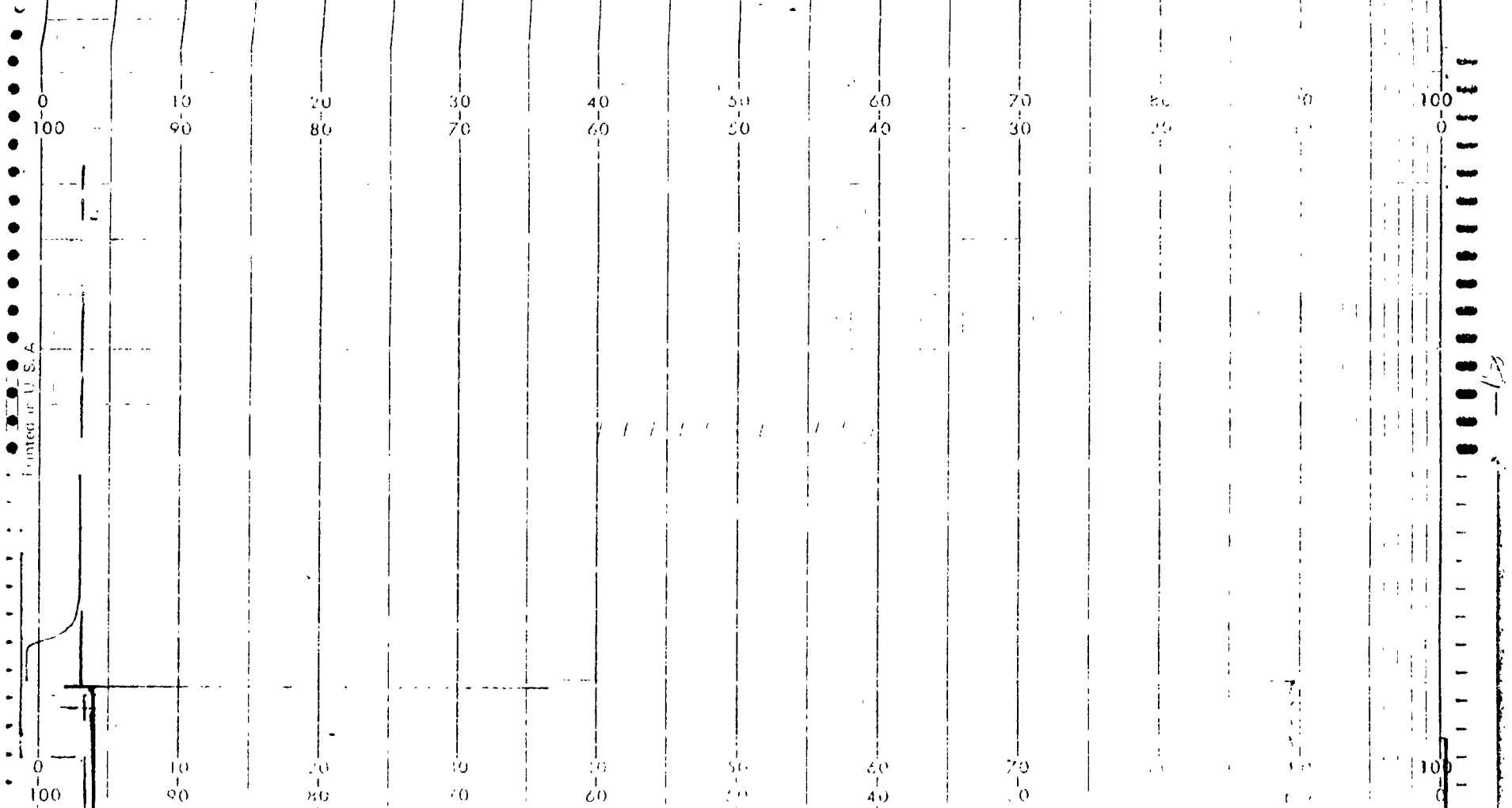
# DRY MOLECULAR WEIGHT DETERMINATION

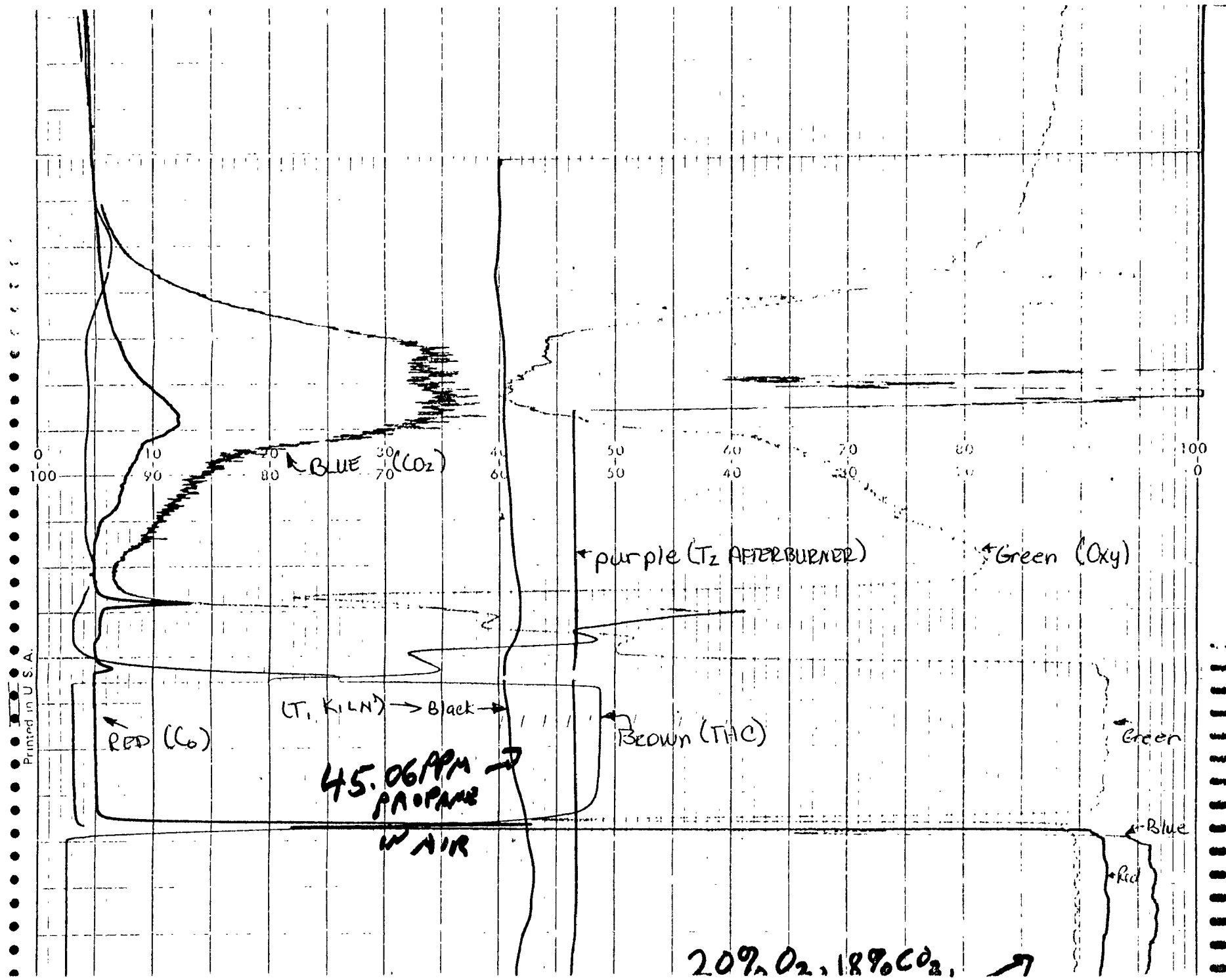
PLANT JOHN ZINC  
 DATE 1 DEC 87  
 SAMPLING TIME (24-hr CLOCK) \_\_\_\_\_  
 SAMPLING LOCATION OUTLET  
 SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS) INTEGRATED  
 ANALYTICAL METHOD OBSAT  
 AMBIENT TEMPERATURE \_\_\_\_\_  
 OPERATOR JAC

COMMENTS: Taken during 3<sup>rd</sup> M108 (As) Run.

RUN GAS	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M <sub>d</sub> , lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO <sub>2</sub>	10.4	10.4	10.2	10.2			10.3	44/100	
O <sub>2</sub> (NET IS ACTUAL O <sub>2</sub> READING MINUS ACTUAL CO <sub>2</sub> READING)	16.0	5.6	16.0	5.8			5.7	32/100	
CO (NET IS ACTUAL CO READING MINUS ACTUAL O <sub>2</sub> READING)								28/100	
N <sub>2</sub> (NET IS 100 MINUS ACTUAL CO READING)								28/100	
TOTAL								29.88	

B DAT TULSA  
RADIAN STRIP CHART CEM DATA  
12-1-87 → 12-4-87





Printed in U.S.A.

RED (Co)

(T, KILN) → Black →

45.06PPM  
PROPANE  
IN AIR

BLUE (CO<sub>2</sub>)

purple (T<sub>2</sub> AFTERBURNER)

Green (Oxy)

Brown (THC)

Green

Blue

Red

20% O<sub>2</sub>, 18% CO<sub>2</sub> →

447.31100

Arto Plu  
Sach

Zero gas (0.29.9/12)

end Test  
20:17 hrs

Brown (H2C)

Red

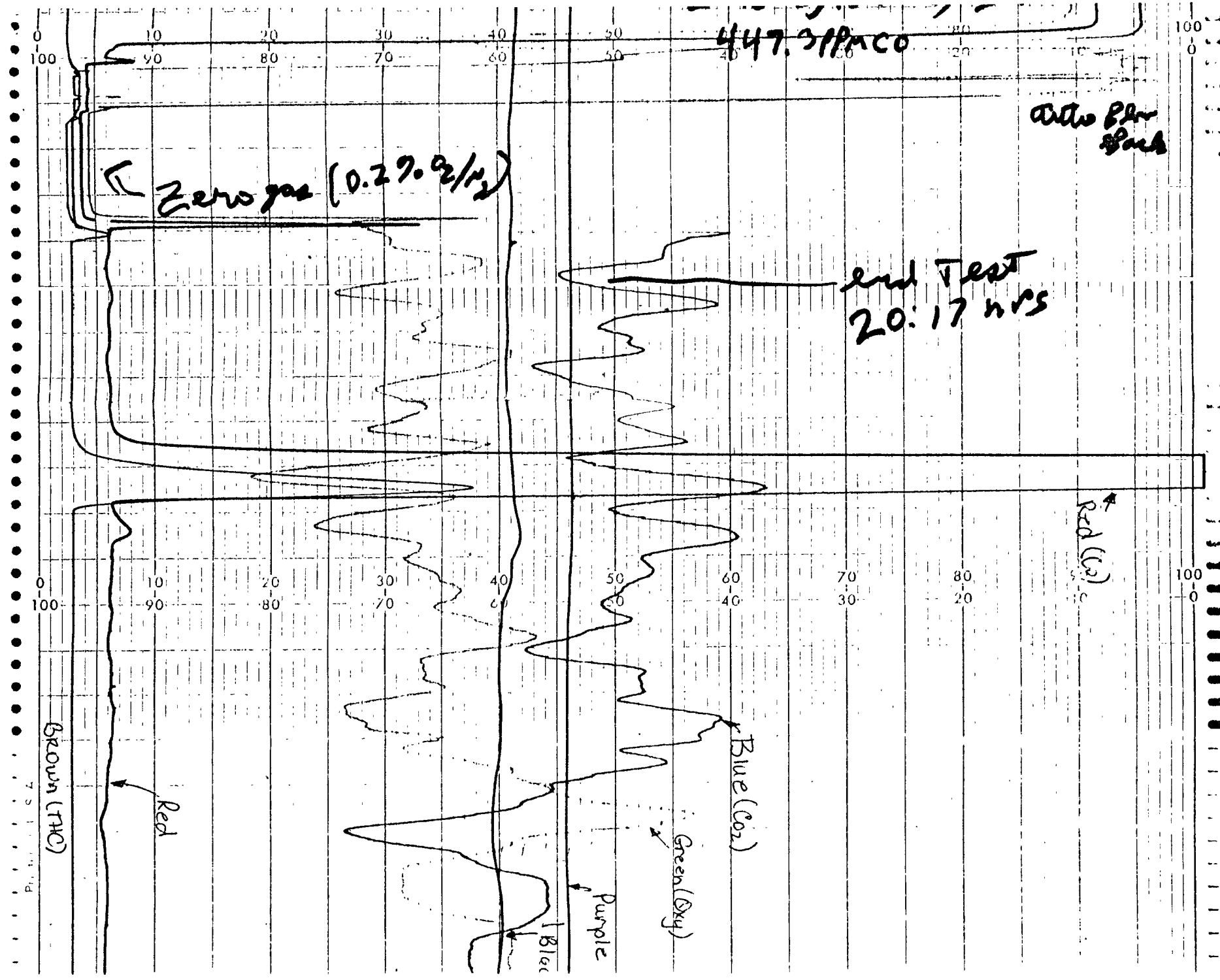
Black

Purple

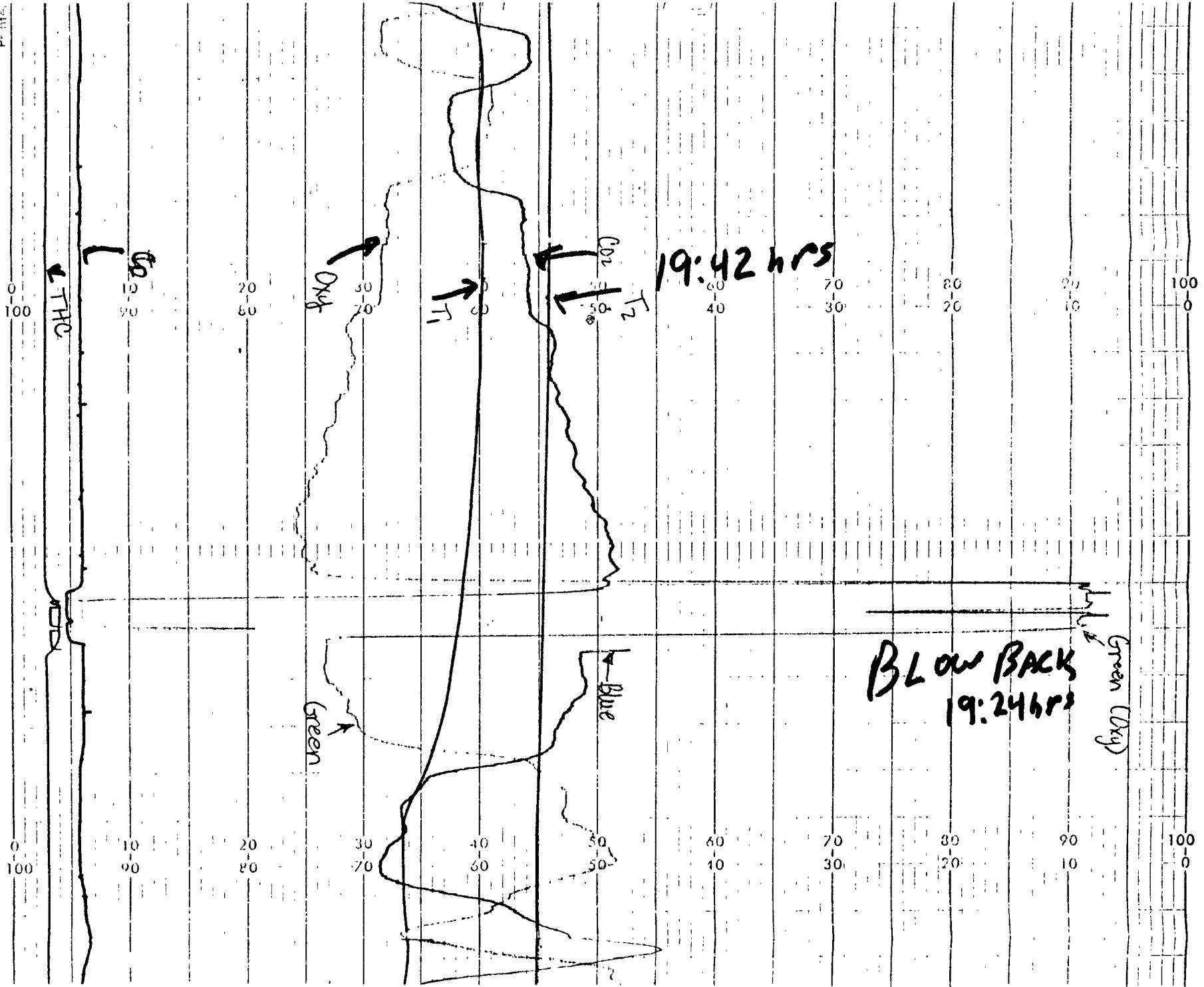
Green (Oxy)

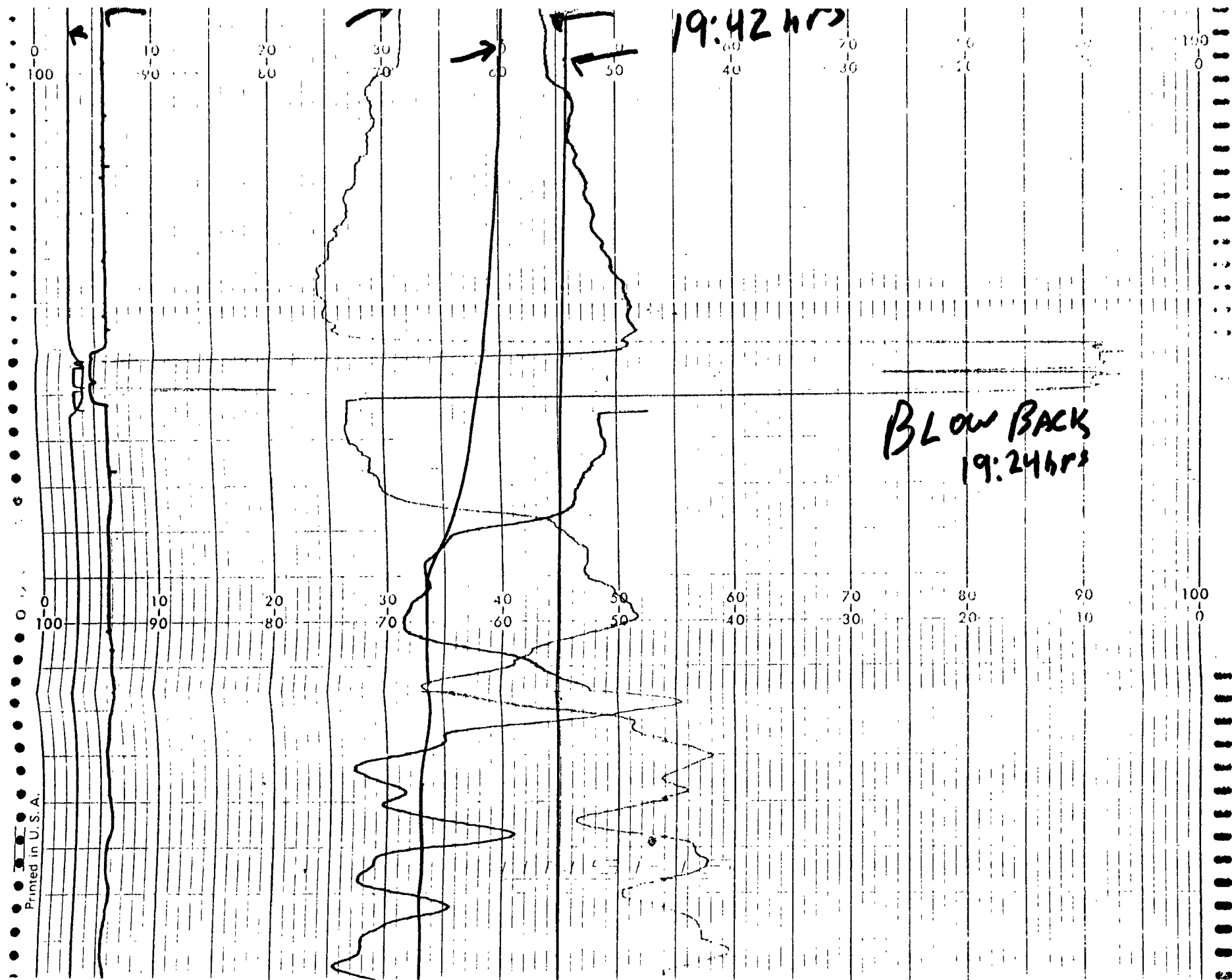
Blue (CO2)

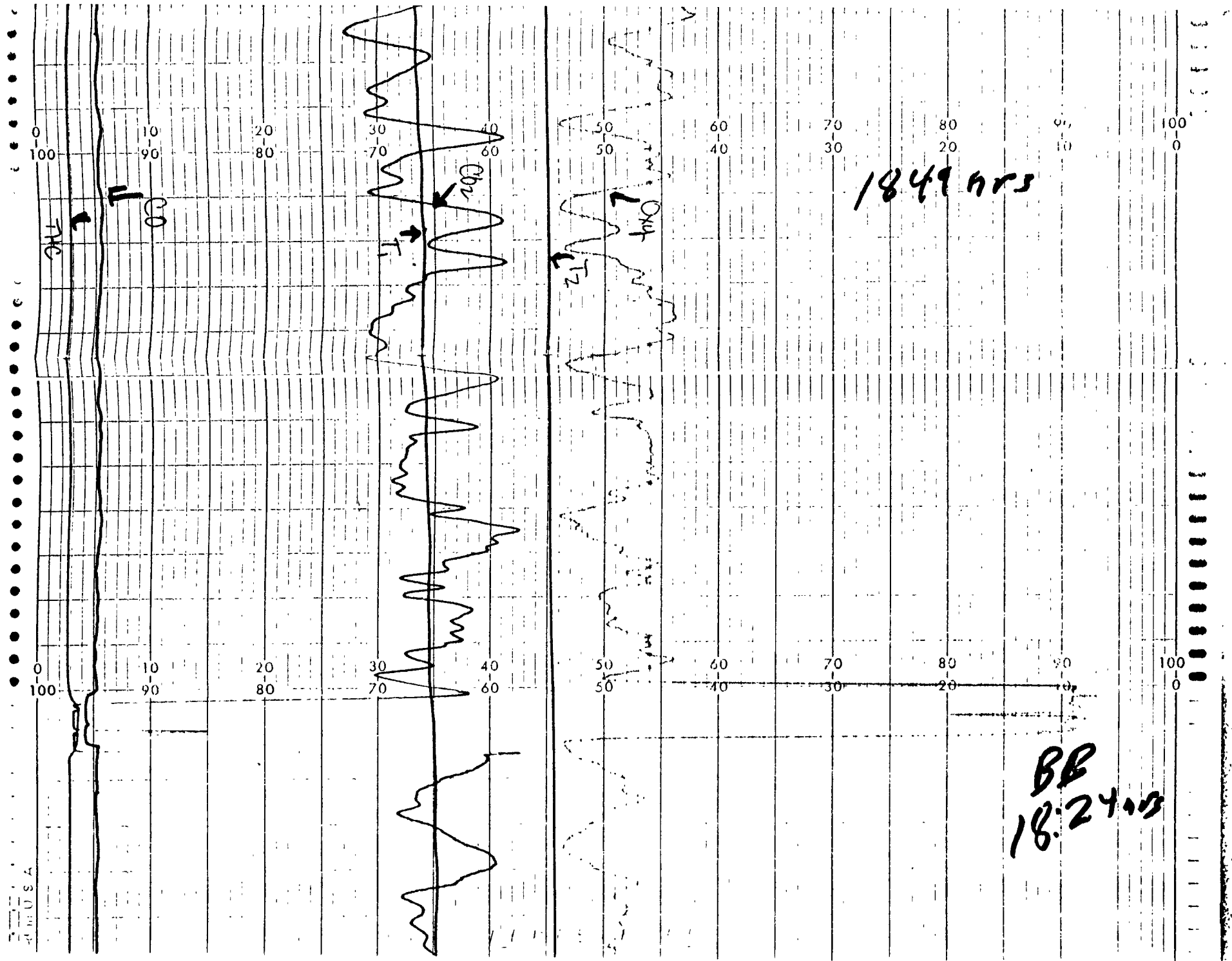
Red (CO2)



Printed





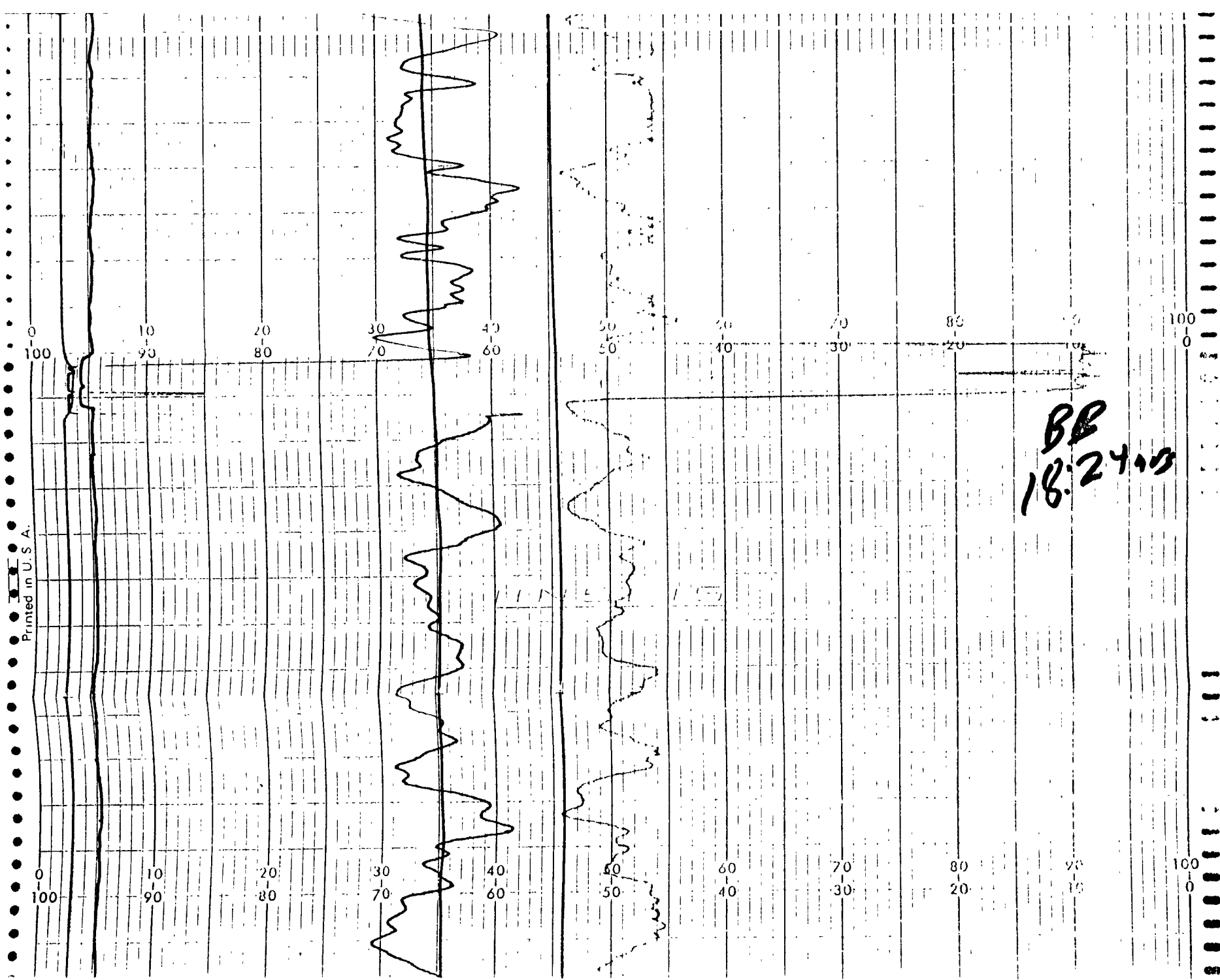


1849 hrs

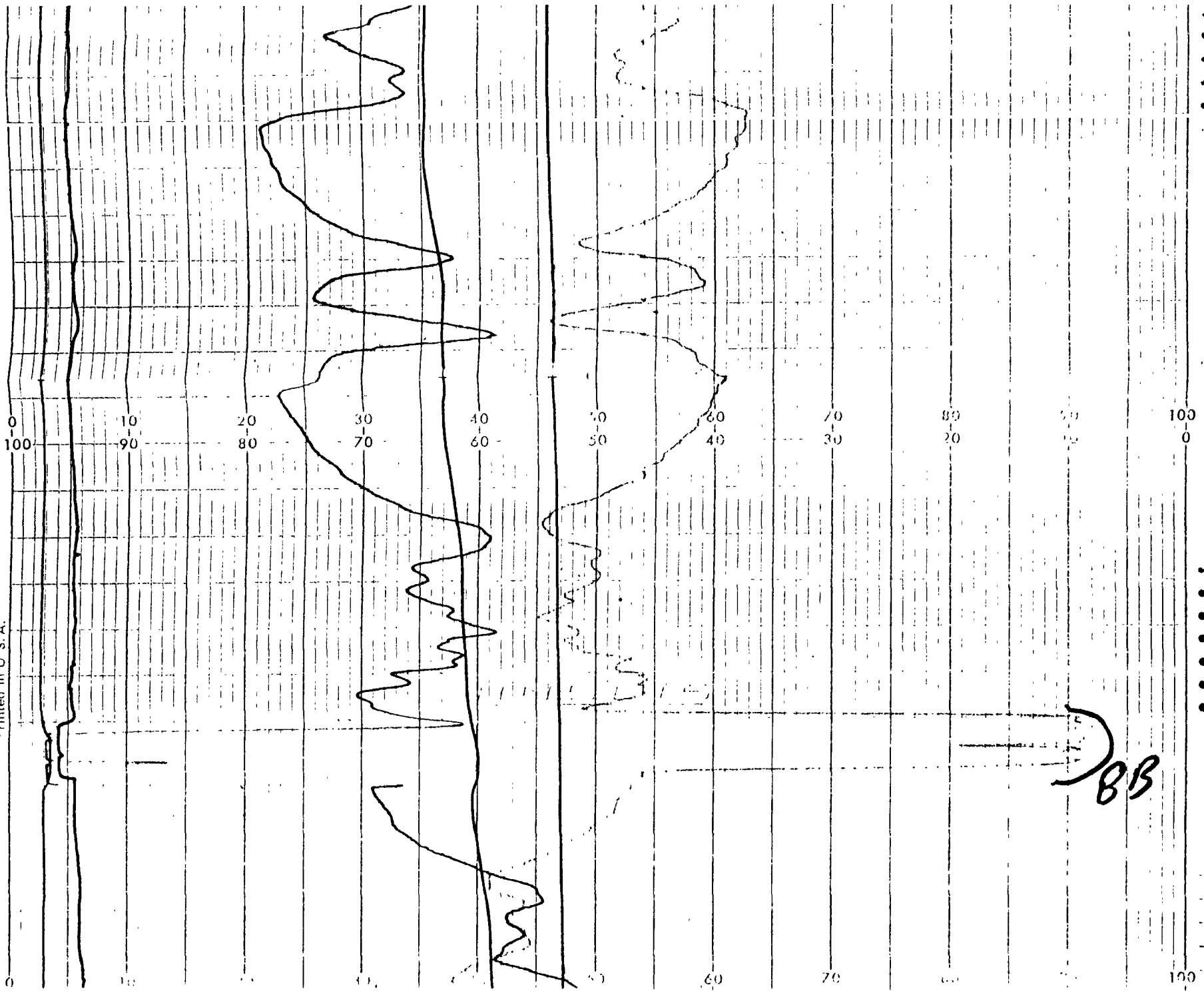
BB  
18:24.03

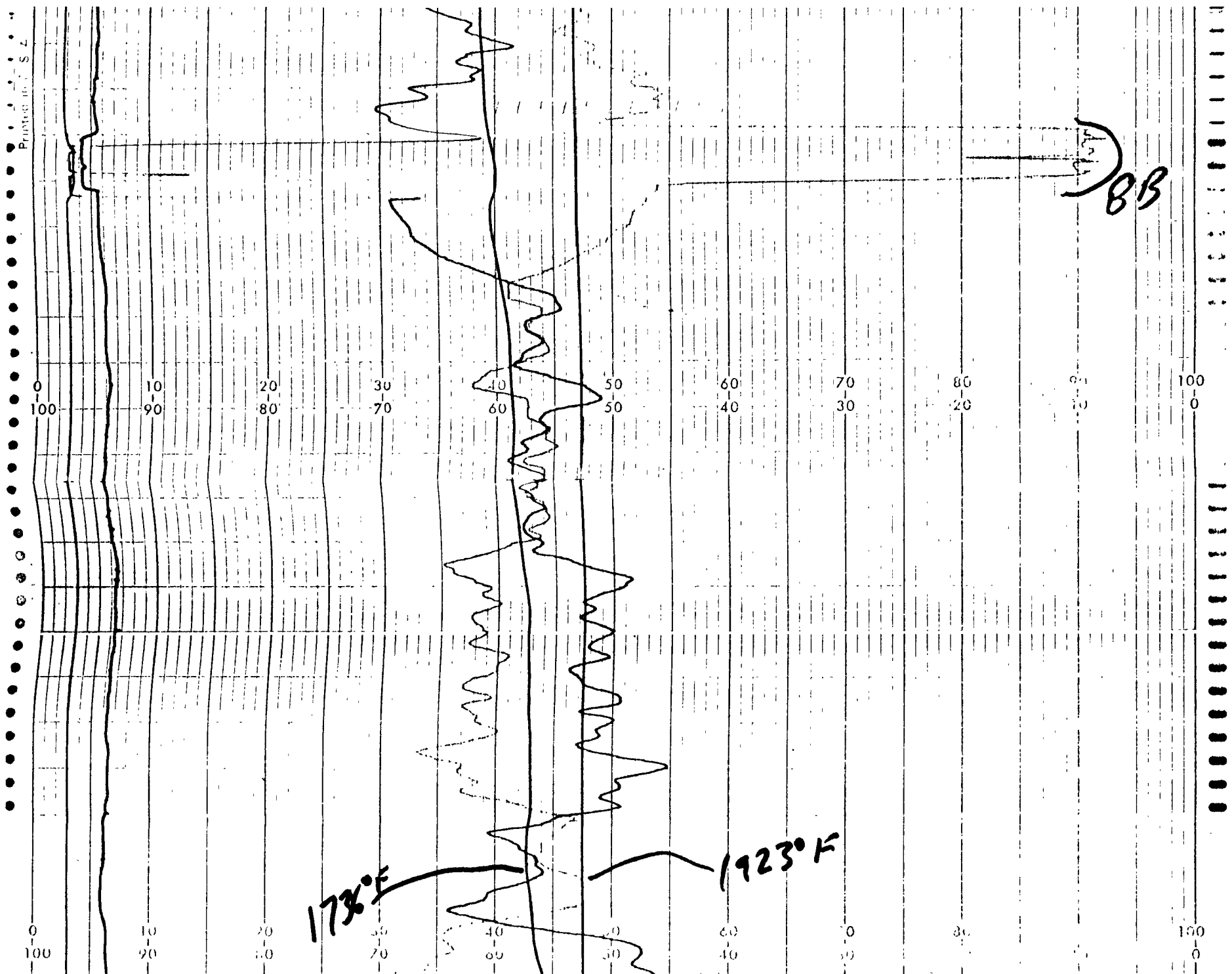


Printed in U.S.A.

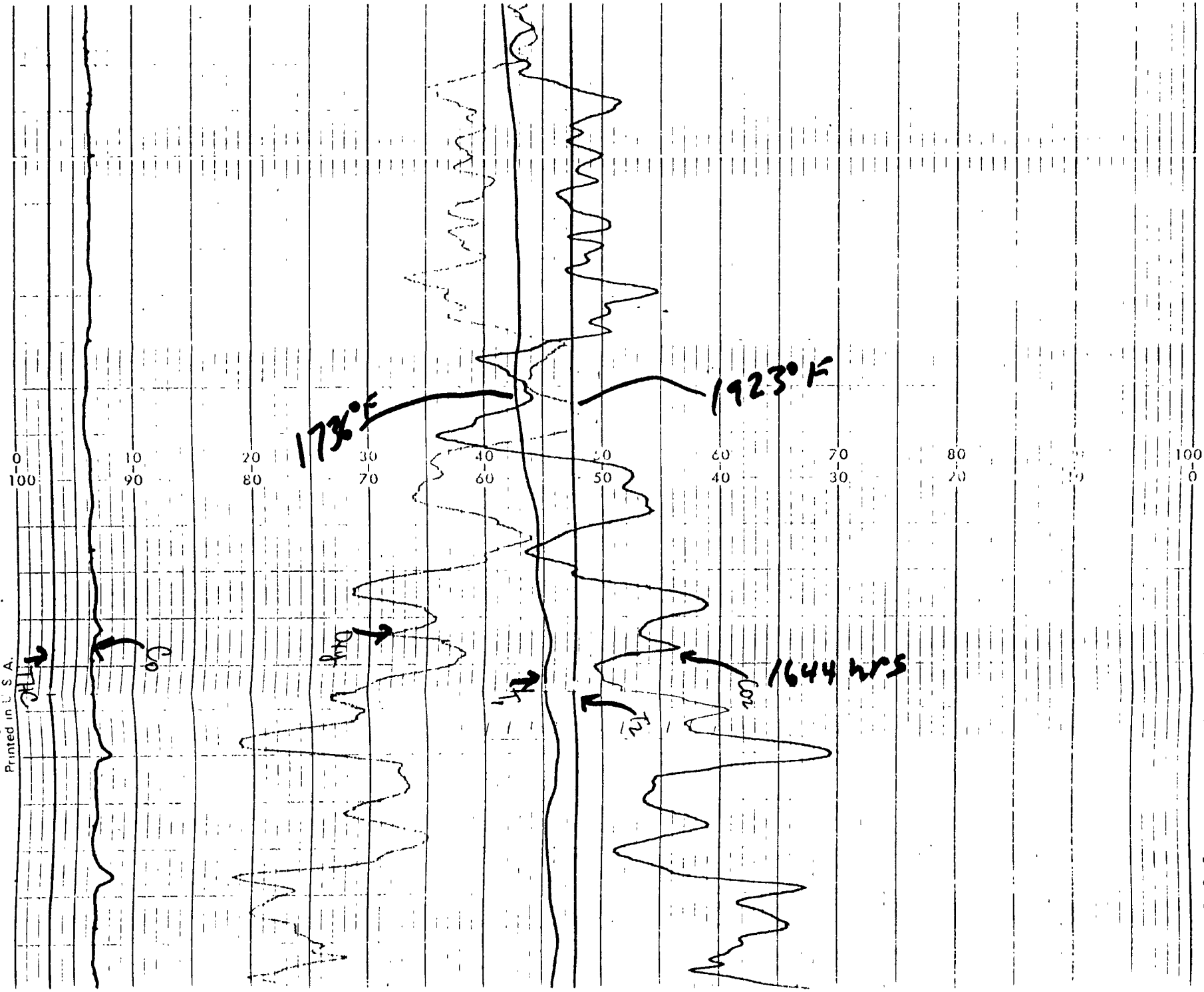


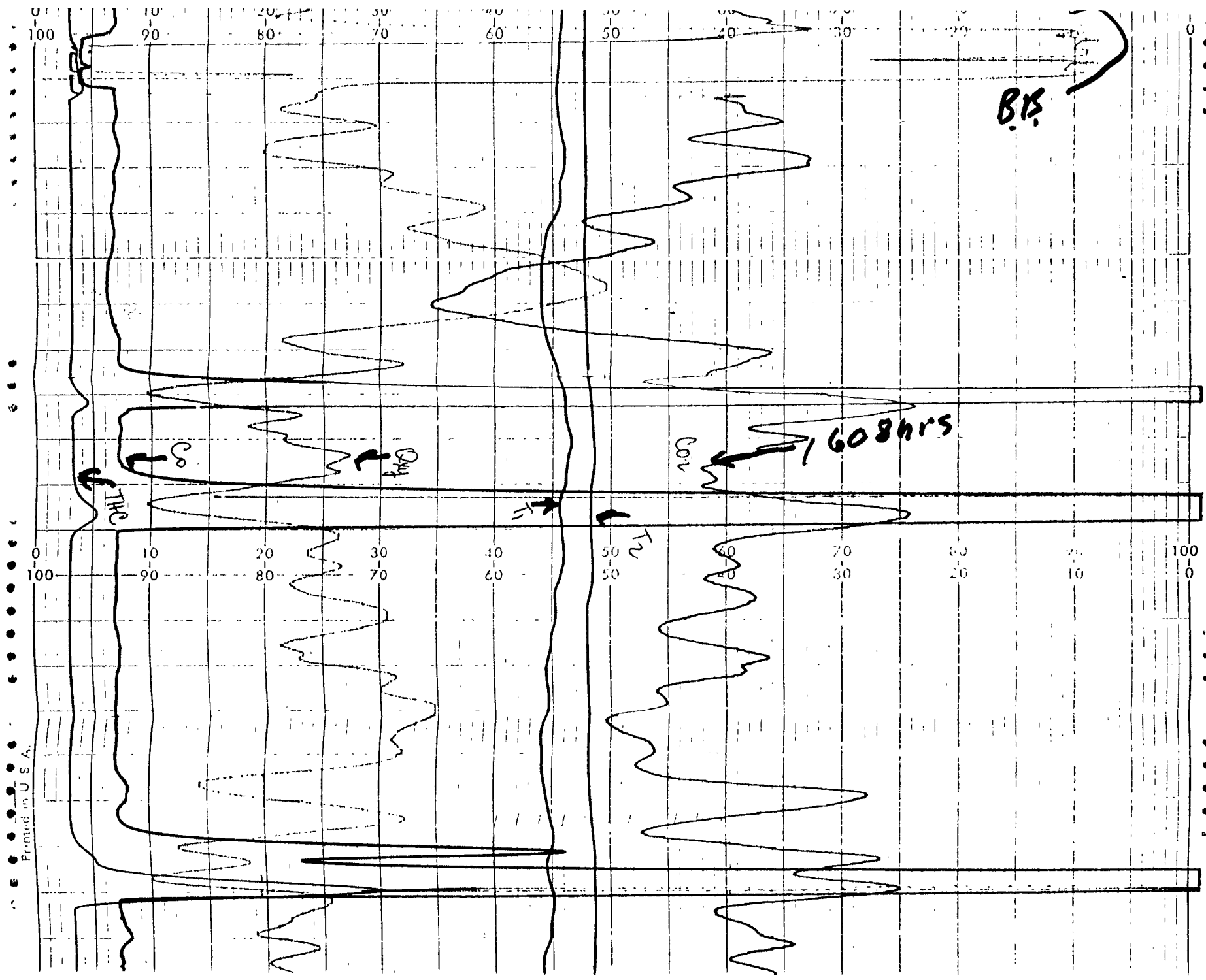
Printed in U. S. A.





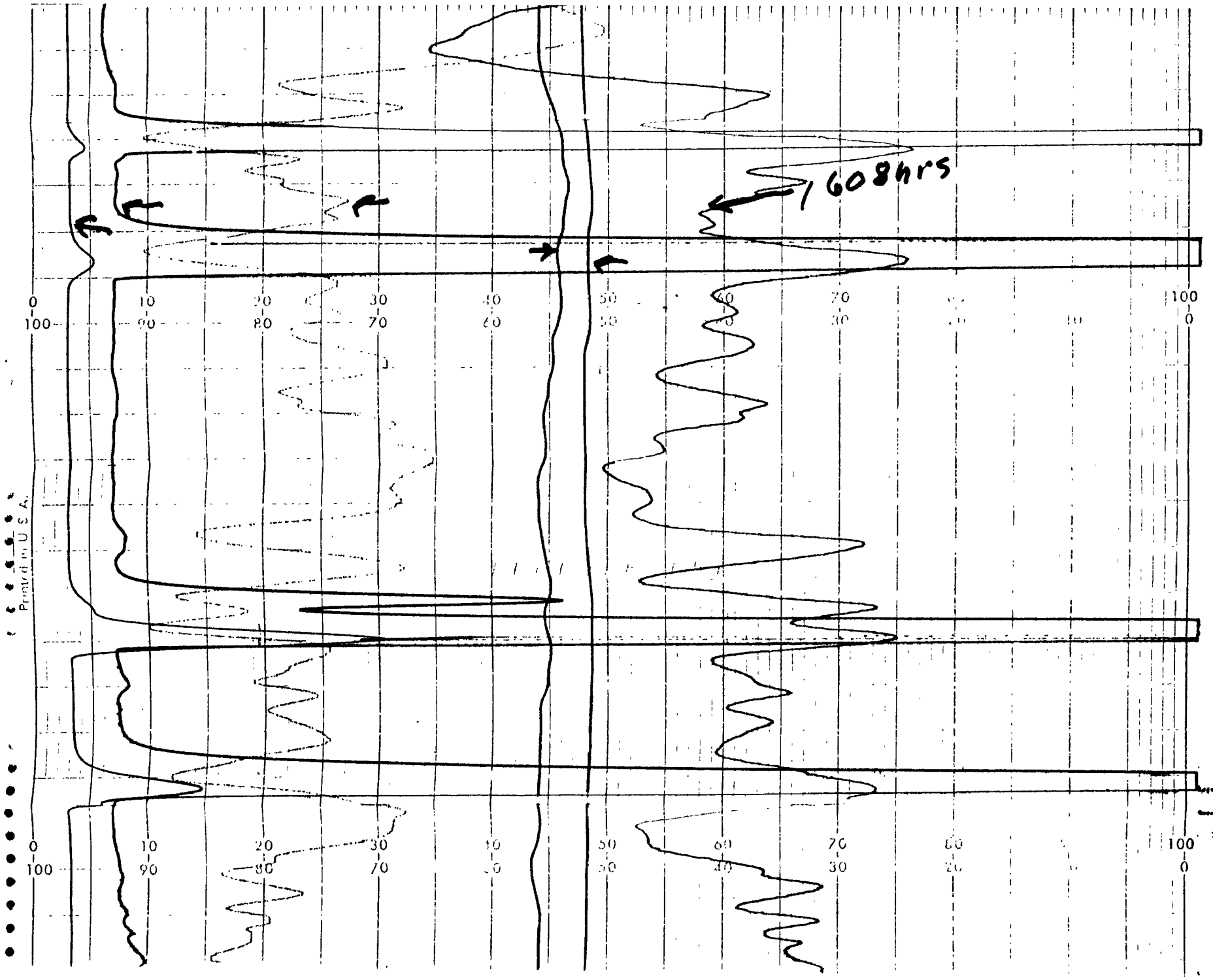
Printed in U.S.A.

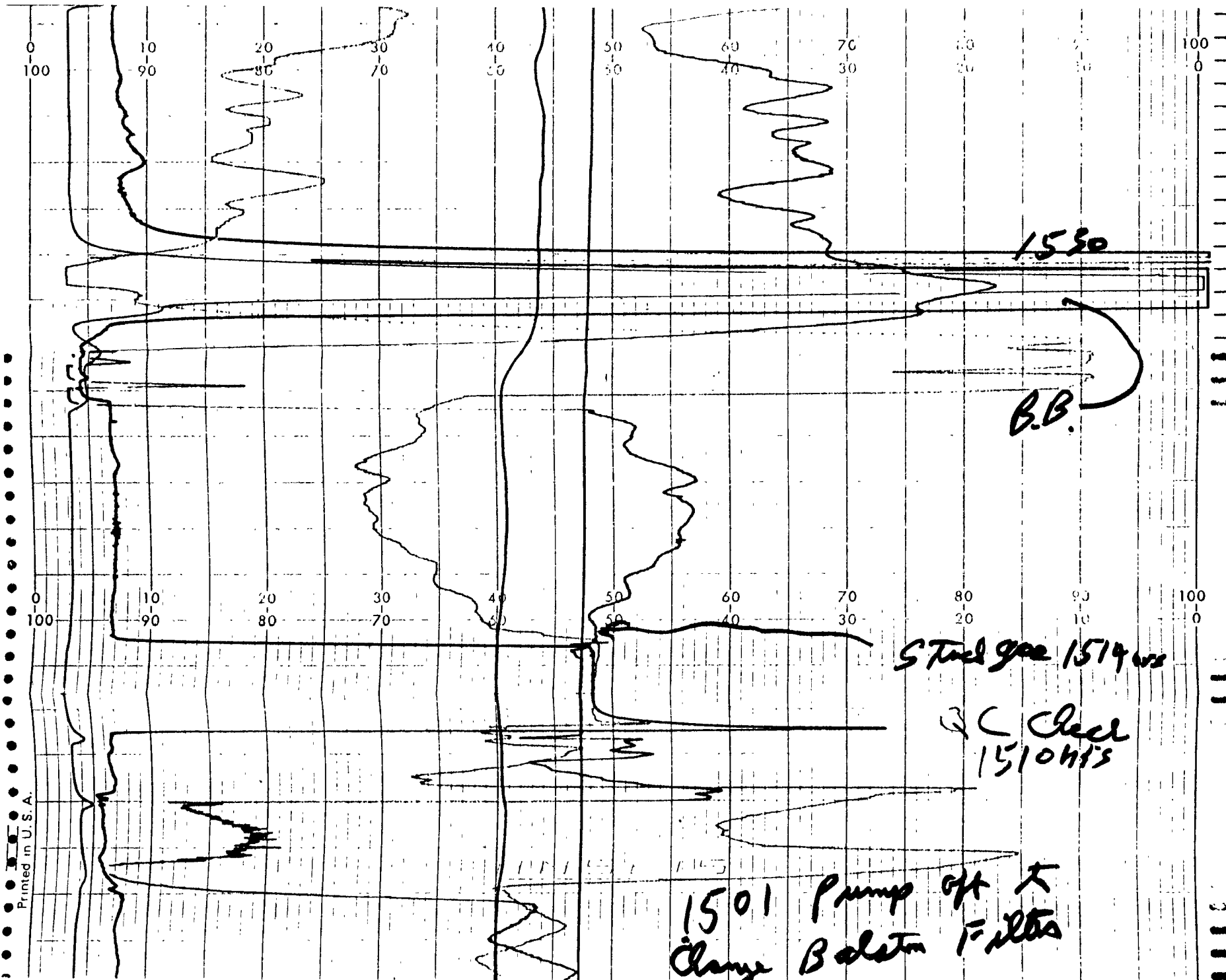




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Printed in U.S.A.





1530

B.B.

5 Fuel gas 1514 hrs

3 C. fuel 1510 hrs

1501 Pump off &  
Change Boleton Filter

Printed in U.S.A.

Pressure SA



0  
100

10  
90

20  
80

30  
70

40  
60

50  
50

60  
40

70  
30

80  
20

90  
10

100  
0

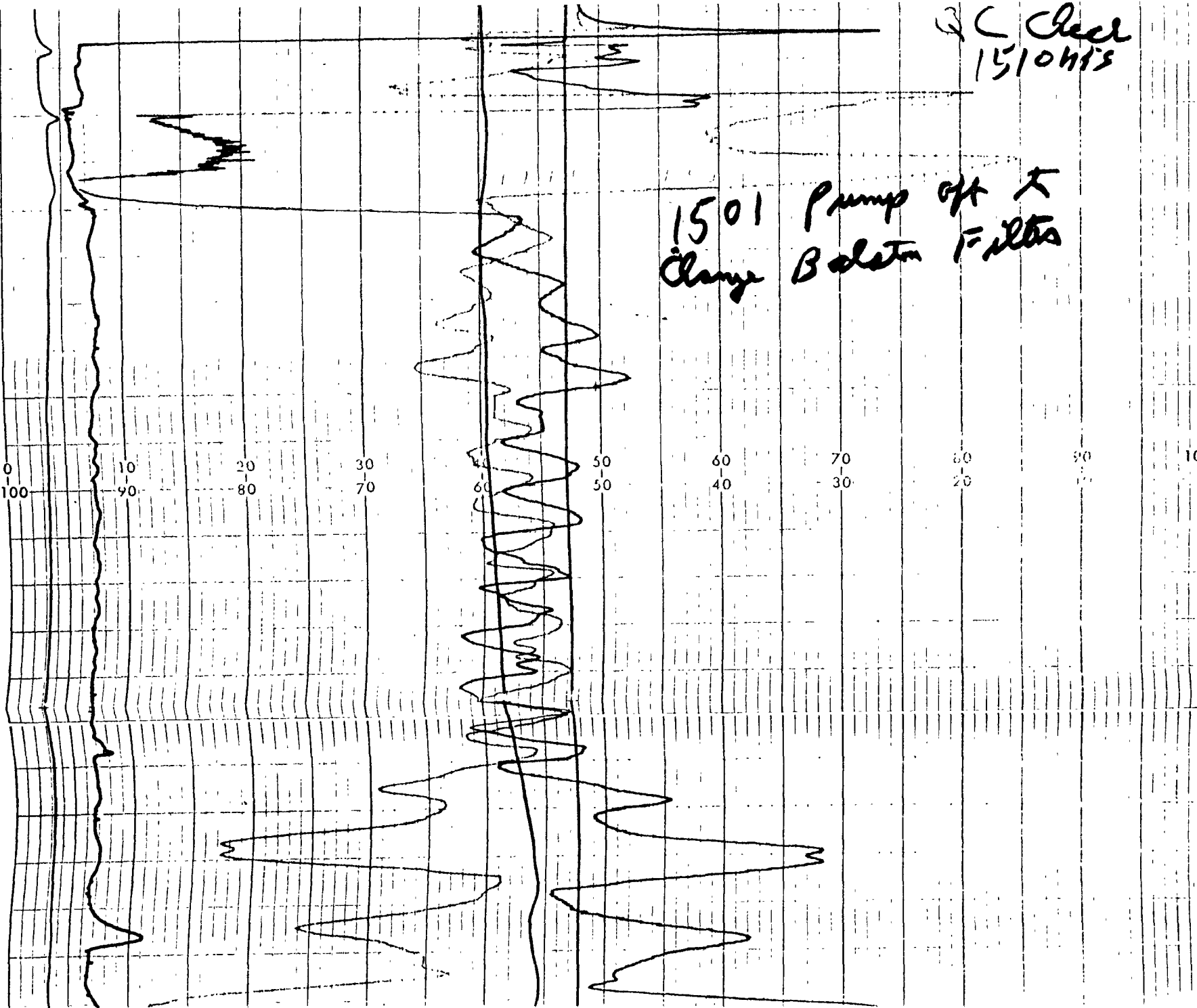


11

12

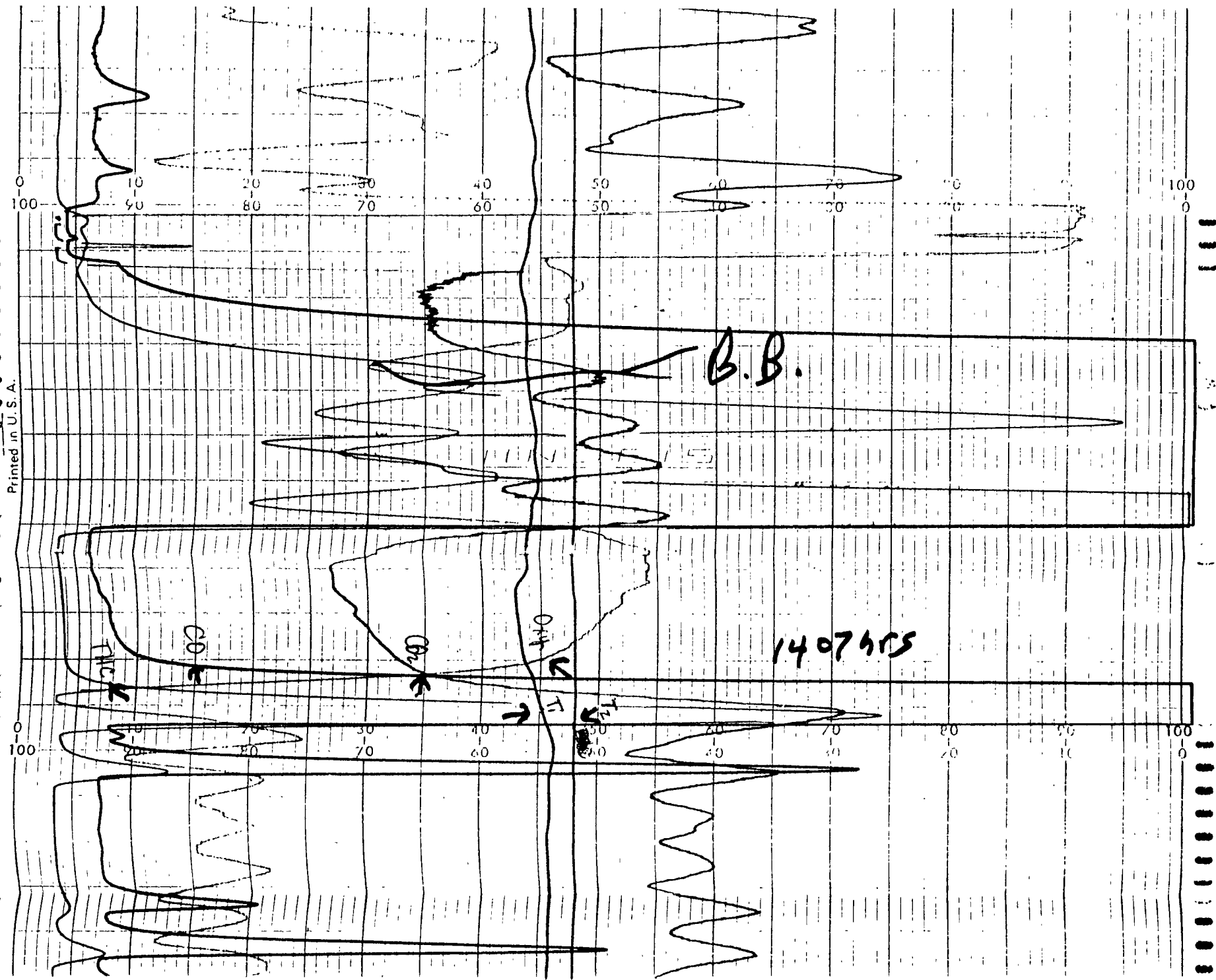
QC Check  
1510415

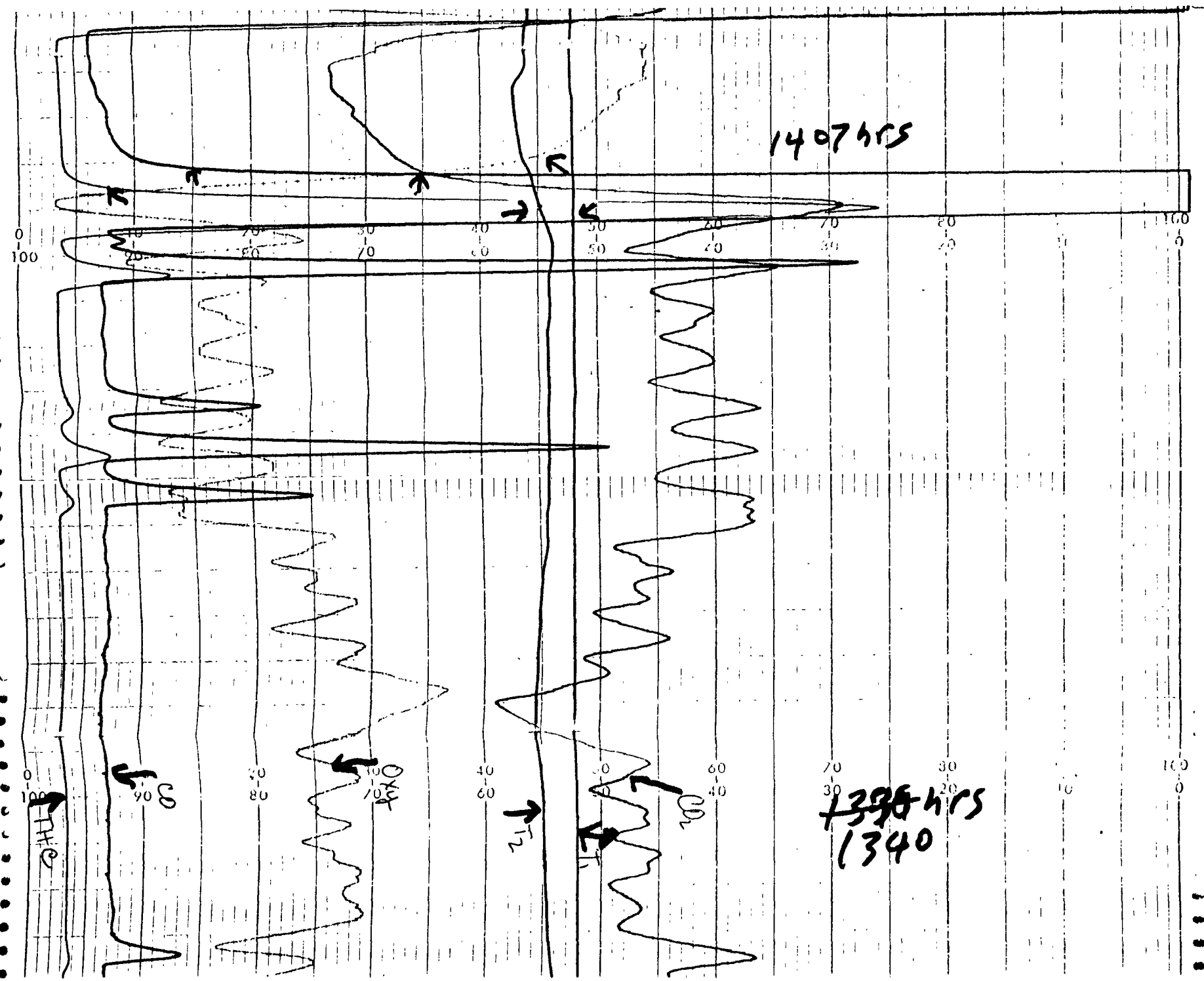
1501 Pump off &  
Change Balance Filter

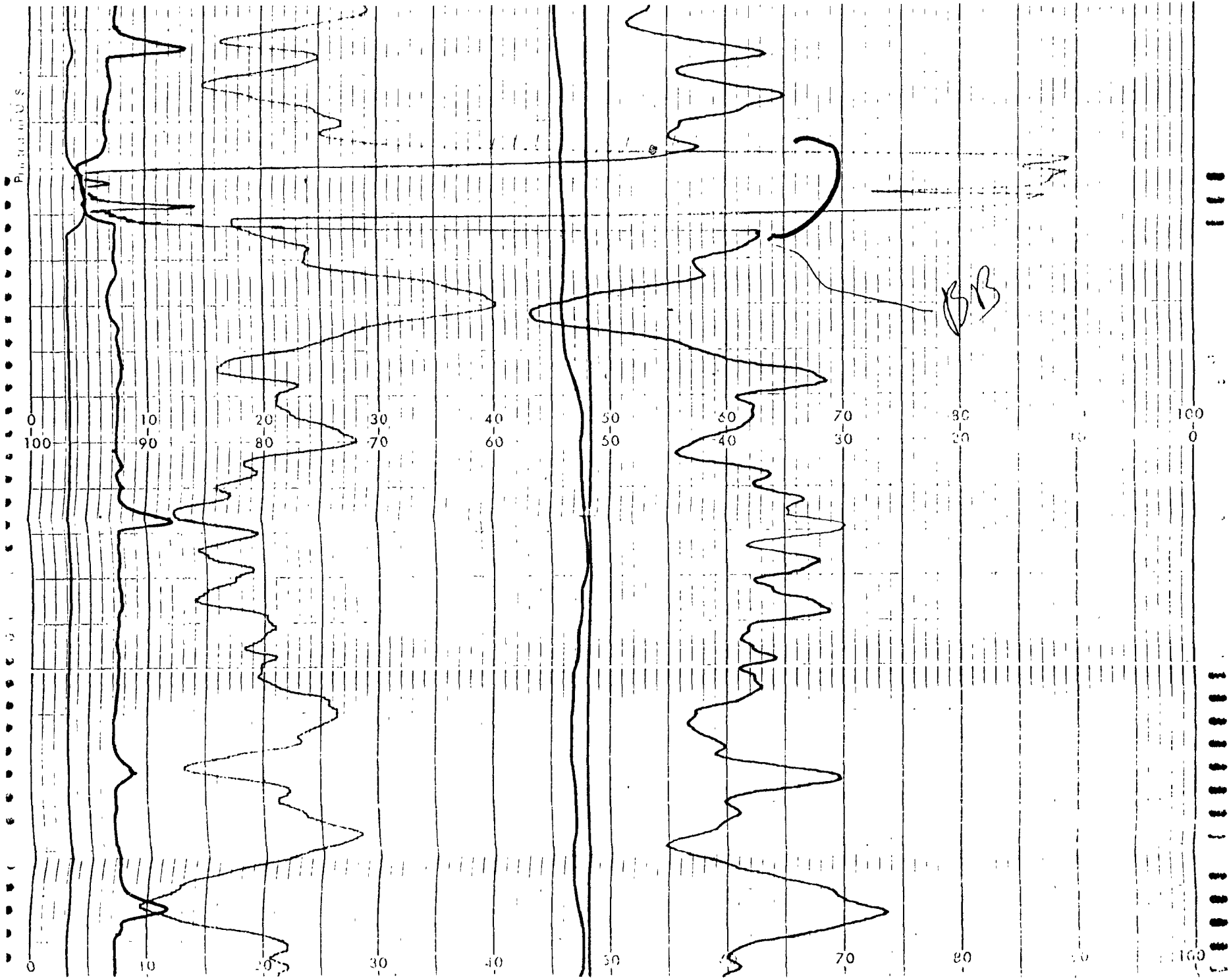


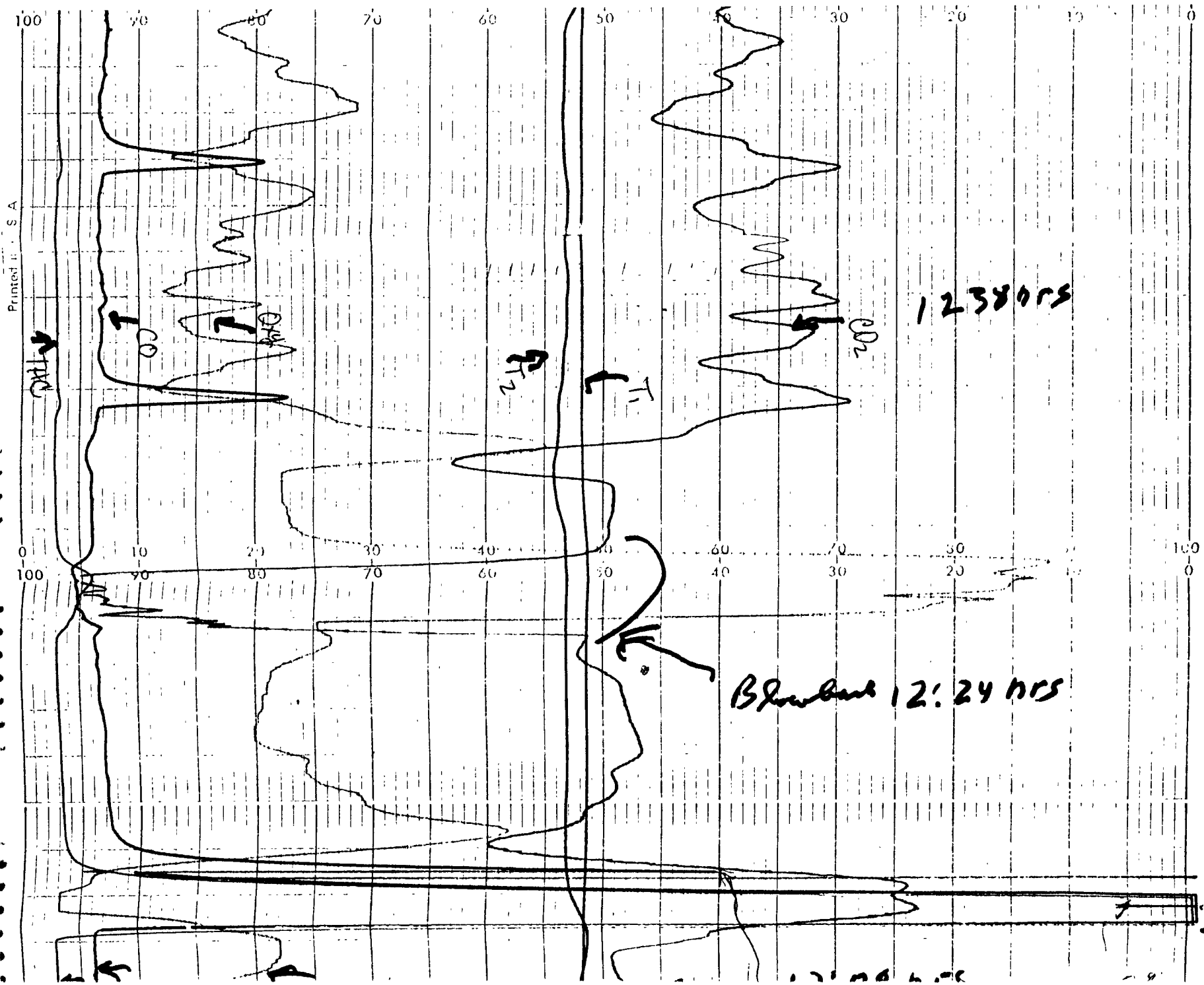


Printed in U.S.A.









Printed in S.A.

100 90 80 70 60 50 40 30 20 10 0

0 10 20 30 40 50 60 70 80 90 100

CO

H<sub>2</sub>O

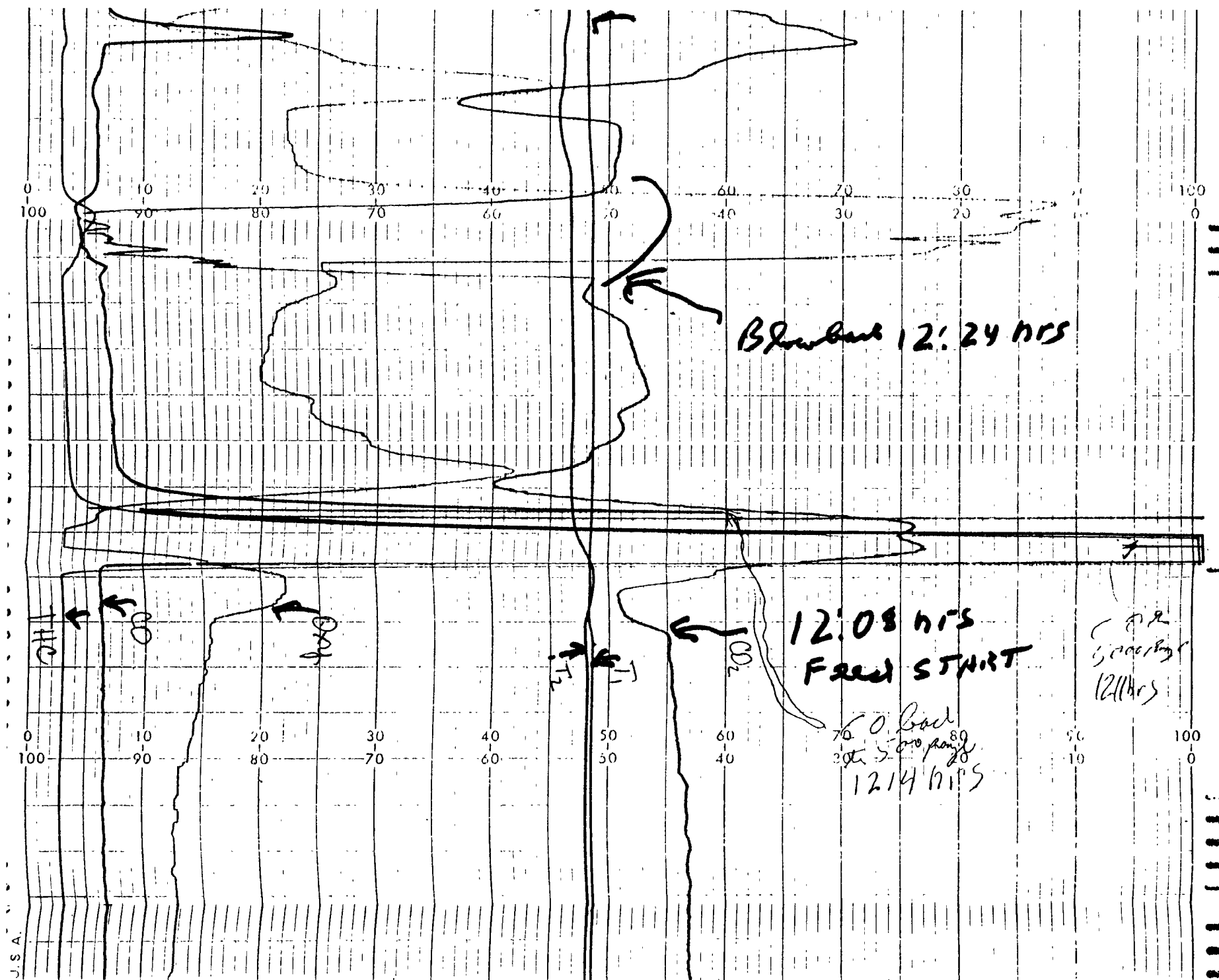
H<sub>2</sub>

O<sub>2</sub>

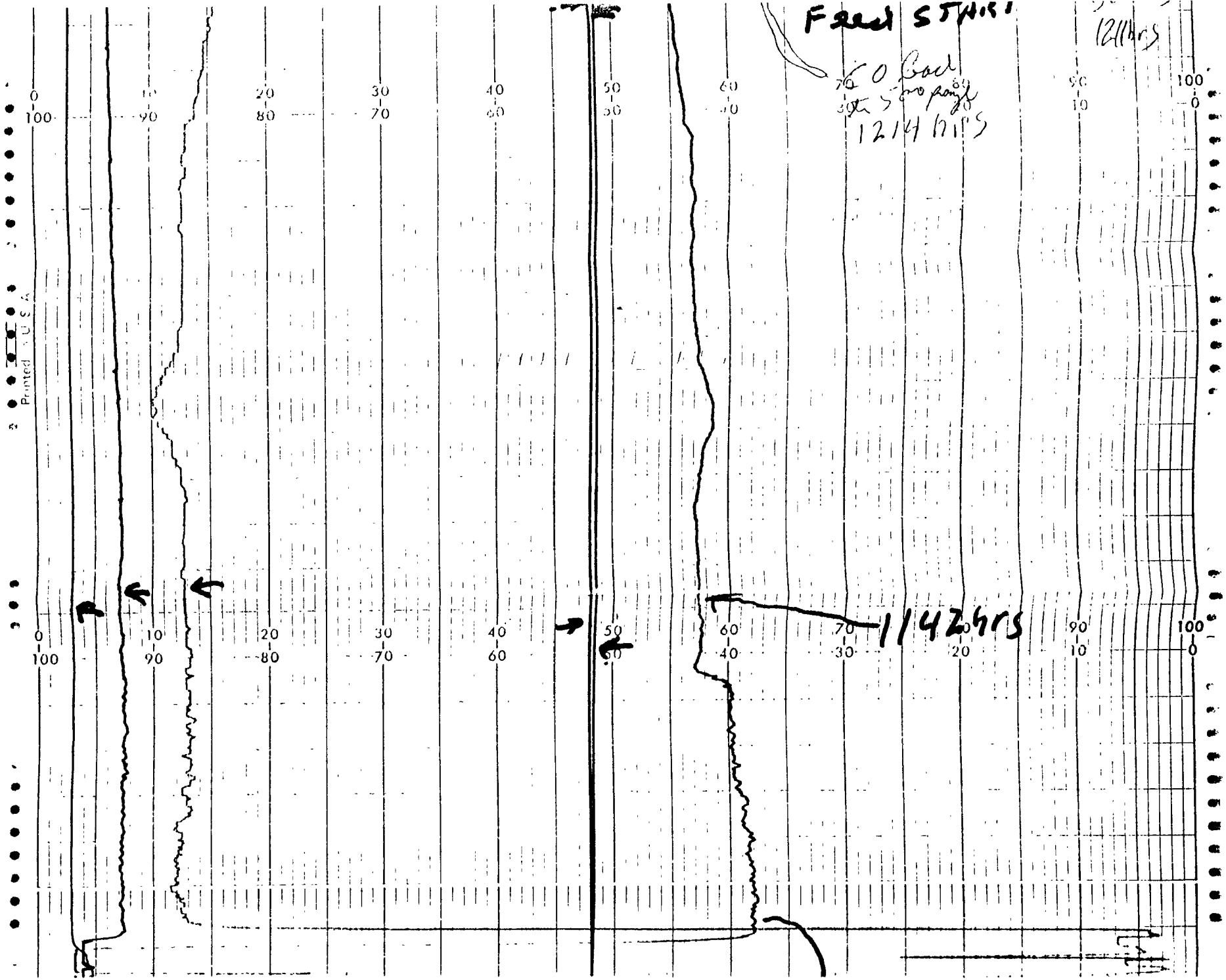
Blank 12:24 hrs

12380rs

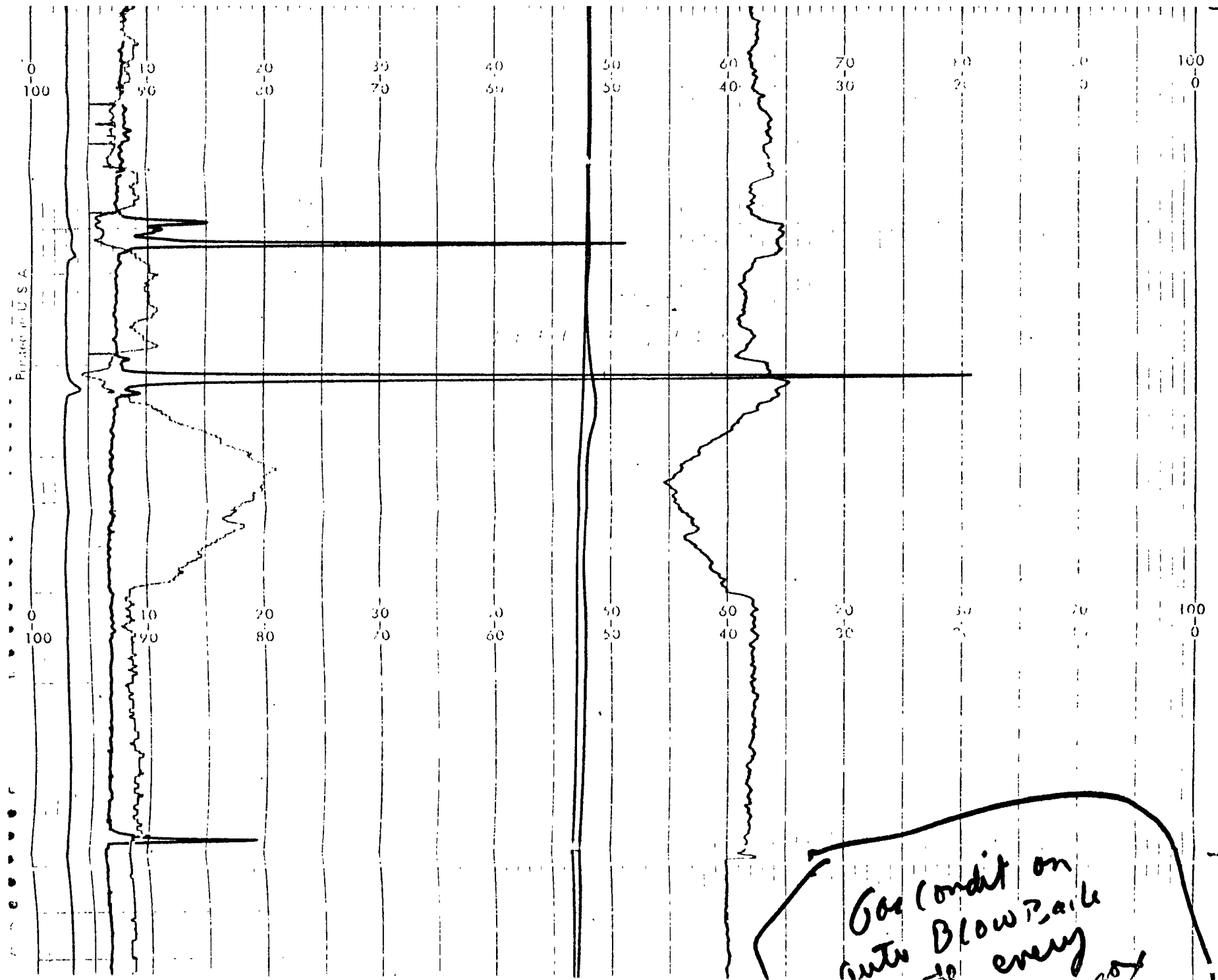
12380rs



U.S.A.





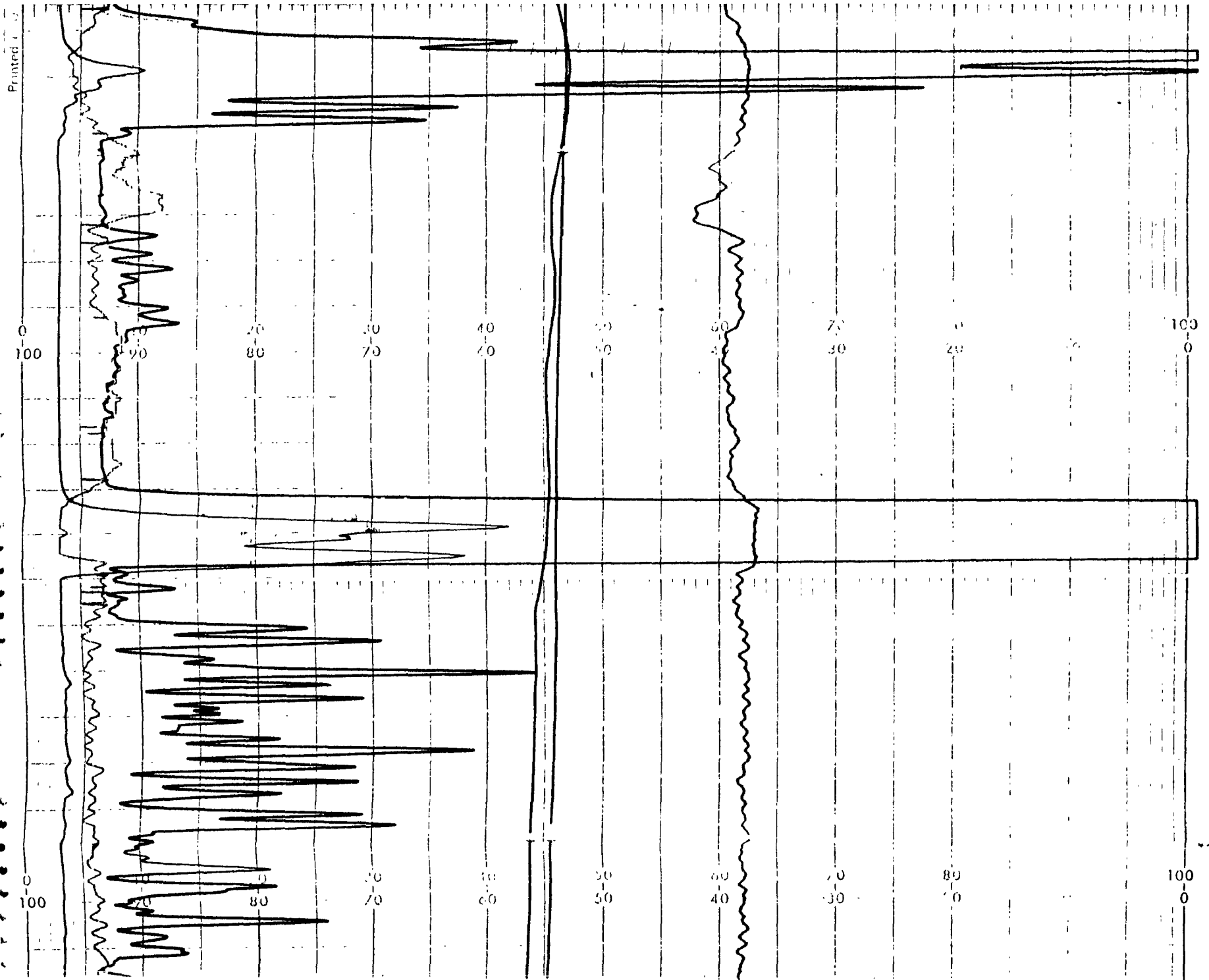




Good Conner  
Auto Blow Pipe  
made every  
Hour @ approx  
25 min past  
Hour

GC Blowback 1026  
Hes  
Computer DAS on  
@ this time

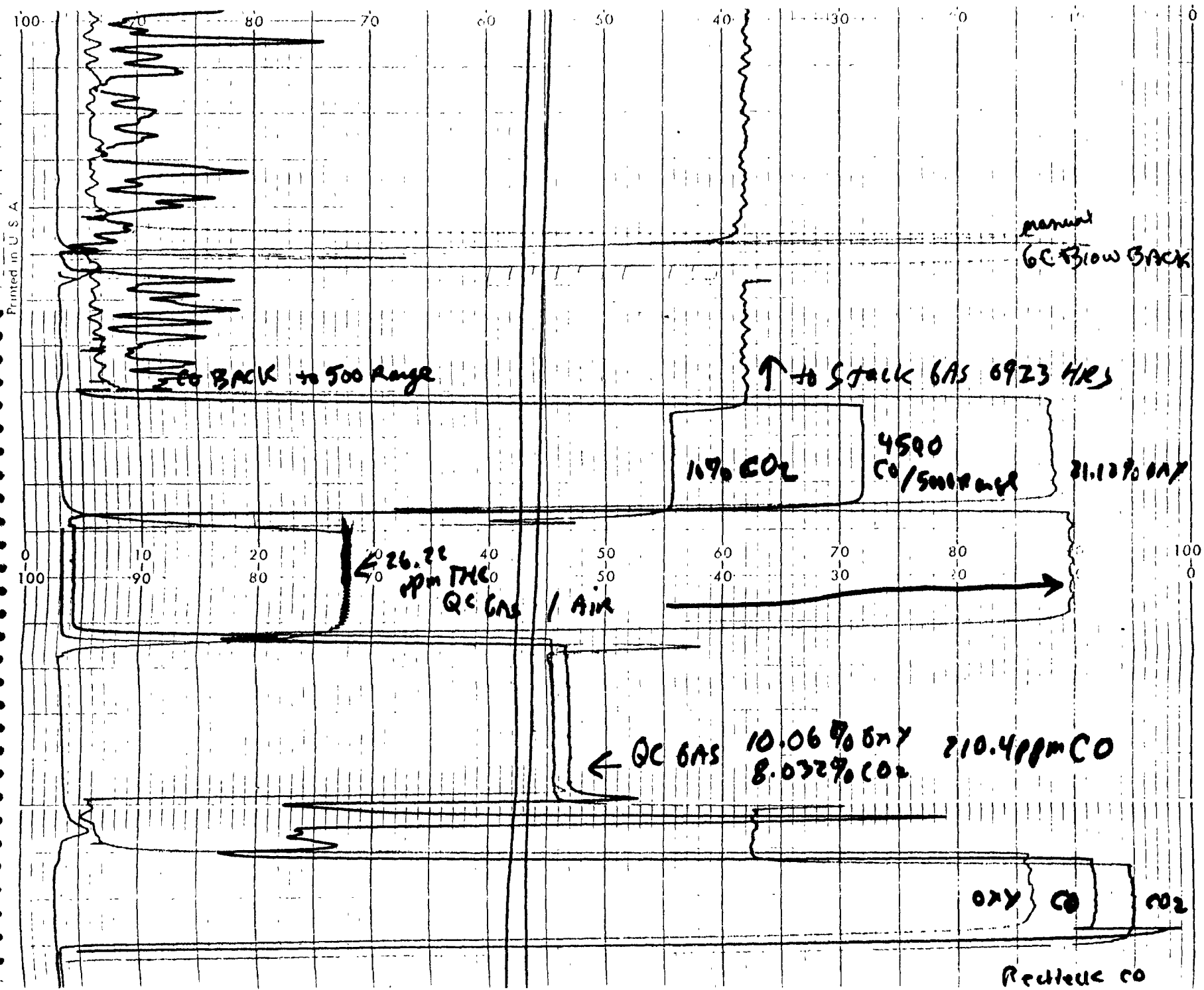
Printed in U.S.A.

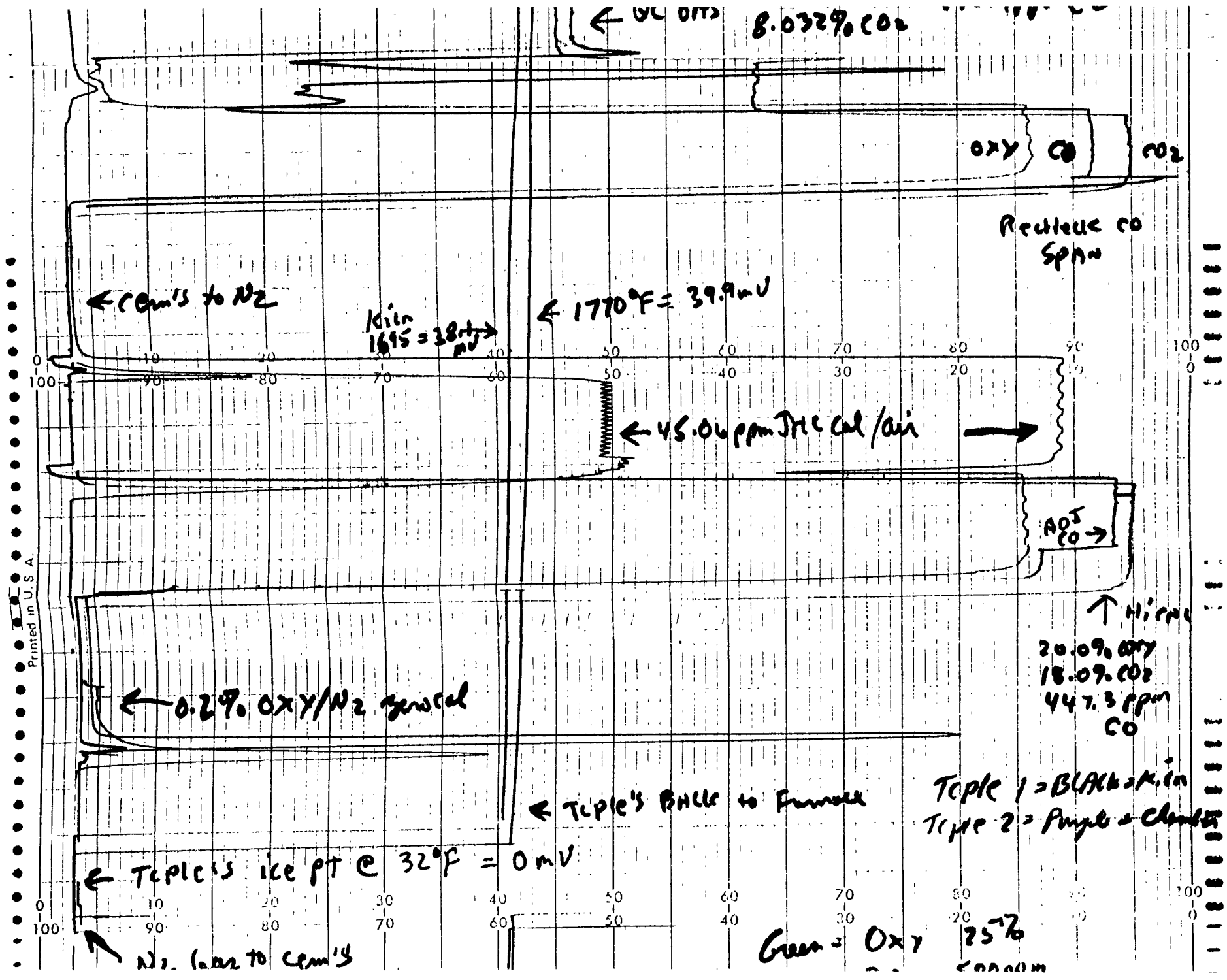


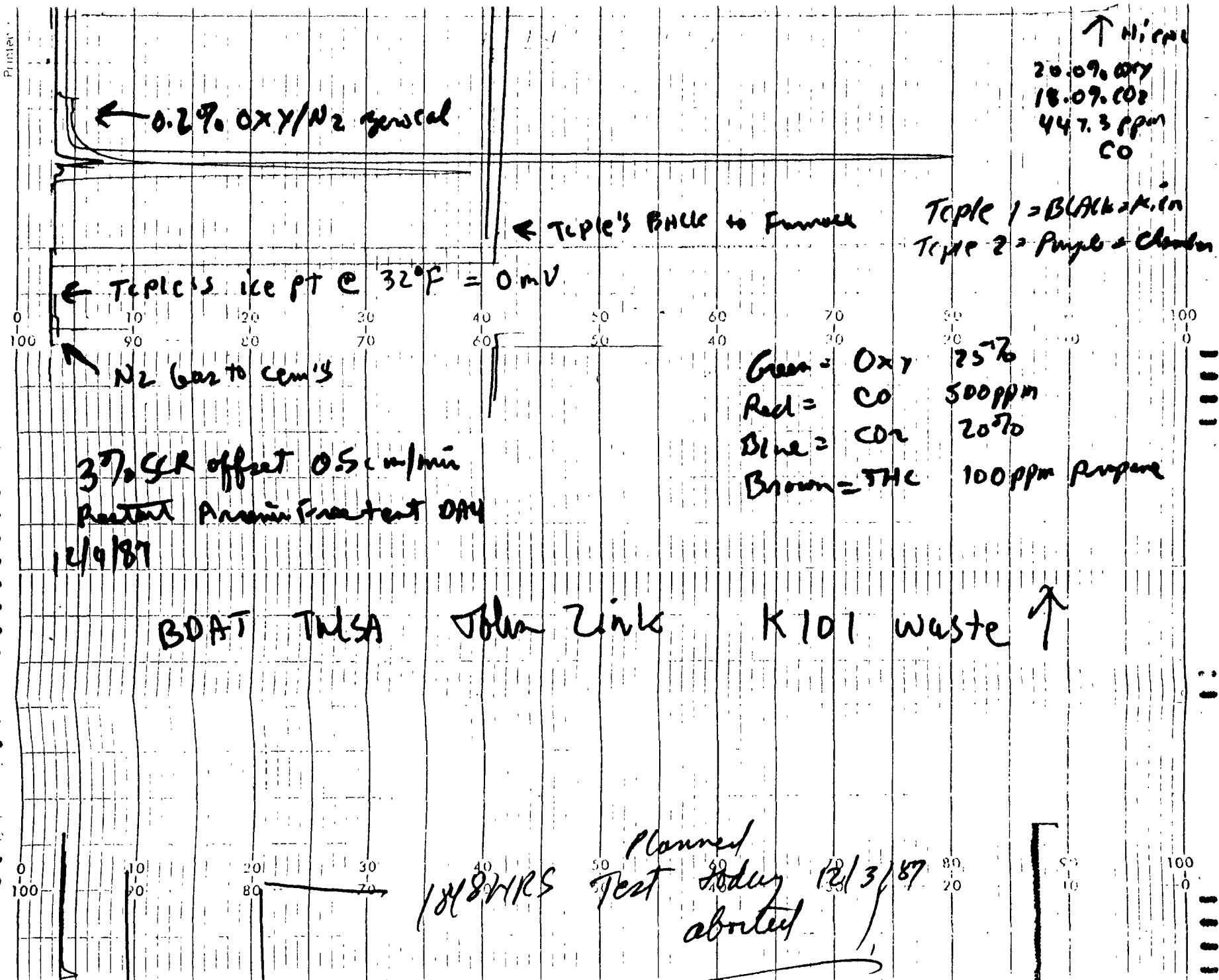
Printed 1-72

GRAPH

Printed in U.S.A.







← 0.2% O<sub>2</sub>/N<sub>2</sub> General

↑ N<sub>2</sub> gas  
20.0% O<sub>2</sub>  
18.0% CO<sub>2</sub>  
447.3 ppm  
CO

← TUPLE'S BACK to Furnace

Tuple 1 = BLACK & K. in  
Tuple 2 = Purple & Chlorine

← TUPLE'S ice PT @ 32°F = 0mV

↑ N<sub>2</sub> Gas to cem's

Green = O<sub>2</sub> 25%  
Red = CO 500ppm  
Blue = CO<sub>2</sub> 20%  
Brown = TMC 100ppm Purple

37% GR offset 0.5 cm/min  
Reactant Arsenic front test DAY  
12/9/87

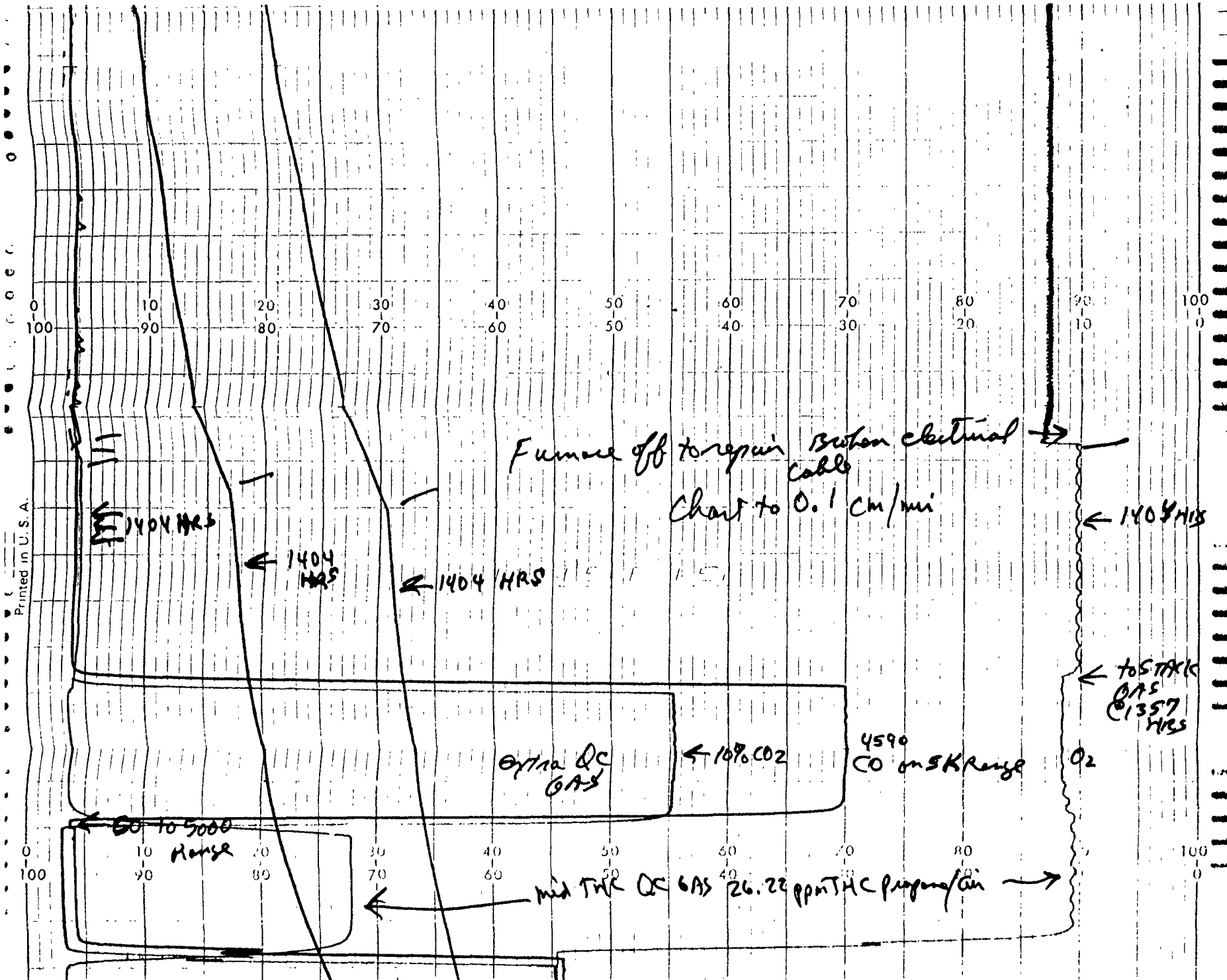
BOAT TMLSA John Zink K101 waste ↑

Planned Test today 12/3/87  
abouted

• • • • •

1848 WRS Test today 12/3/87 abouted

11/11/53



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111

1404 HRS

1404 HRS

1404 HRS

Extra QC GAS

10% CO2

4590 CO on SK Range

50 to 5000 Range

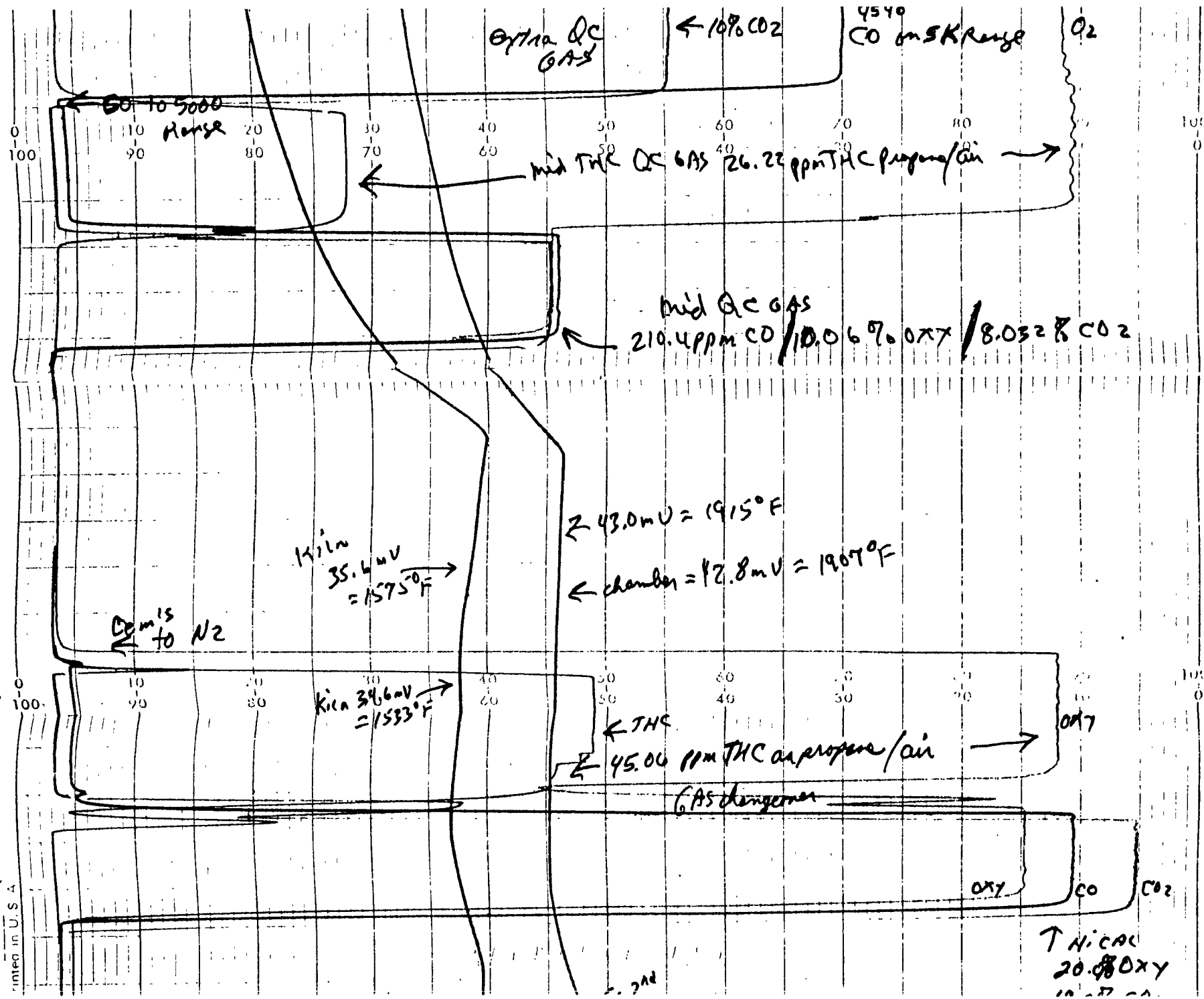
Mid TWC QC GAS 26.22 ppm THC per ppm air

1404 HRS

to STARK GAS @ 1357 HRS

O2

Furnace off to repair broken electrical cable Chart to 0.1 cm/min



Extra QC GAS

← 10% CO2

4540 CO on 5K range

O2

50 to 5000

Range

mid TWC QC GAS 26.22 ppm THC propane/air →

mid QC GAS  
210.4 ppm CO / 10.06 % O2 / 8.032 % CO2

K1 in  
35.4 mV  
= 1575°F

43.0 mV = 1915°F

← chamber = 22.8 mV = 1907°F

O2 in to N2

K1 ch 34.6 mV  
= 1533°F

← THC

45.00 ppm THC air propane/air →

GAS changer

O2

CO

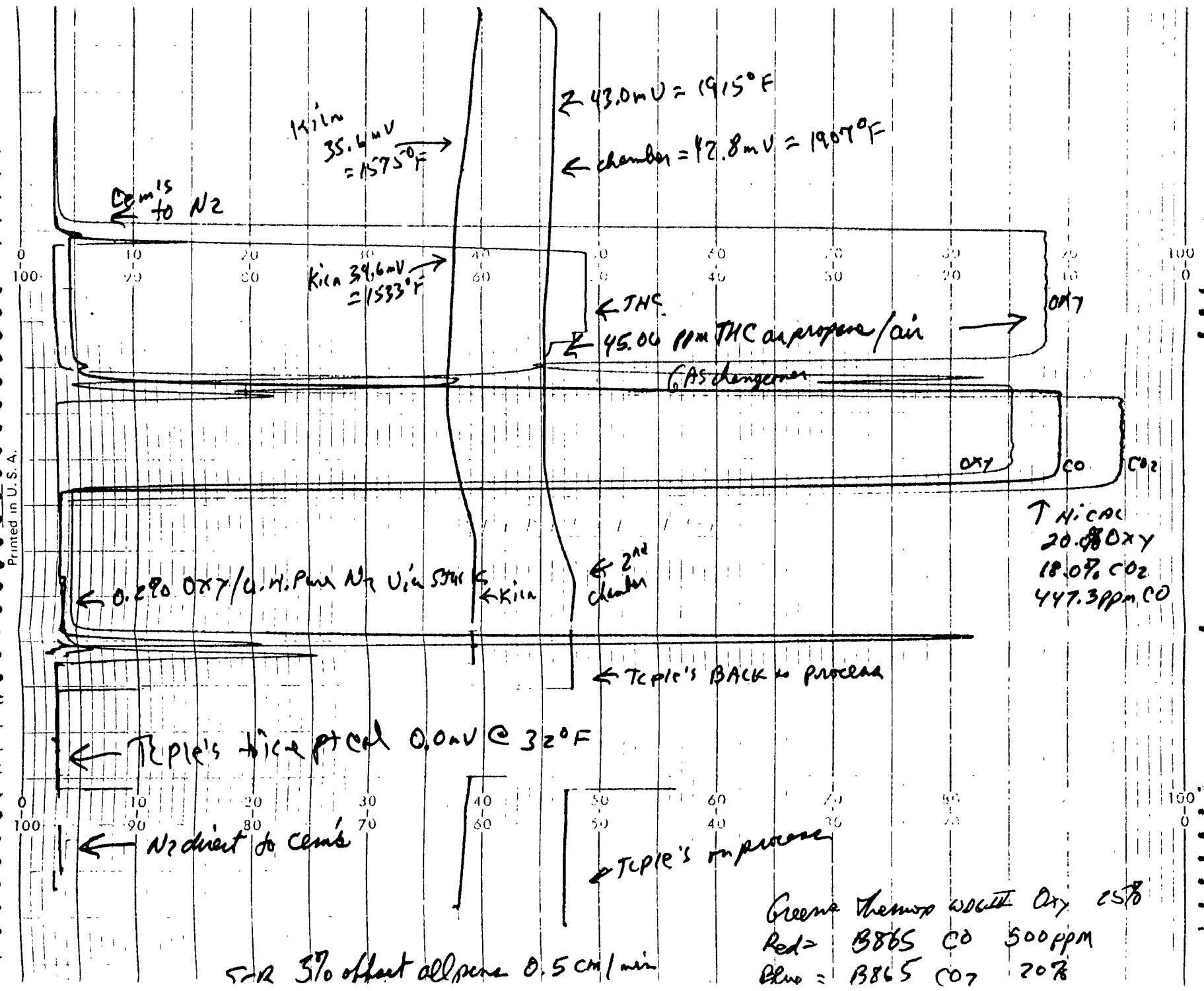
CO2

T HICAC  
20.88 OXY  
10.27 CO

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Printed in U.S.A.



end BOAT/Tulsa 12/1/87 @ 2228 HRS

← 45.00 ppm THC as propane / air

← 0.2% O<sub>2</sub> / N<sub>2</sub> for Thermap

← N<sub>2</sub> gas near stack

Post cal span  
20.09% O<sub>2</sub>  
18.09% CO<sub>2</sub>  
447.3 ppm CO

← N<sub>2</sub> zero for cal

← end Run @ 2208 HRS

2200 HRS  
Blowdown

TCPLP's run

SCR 3% offset all pens 0.5 cm/min

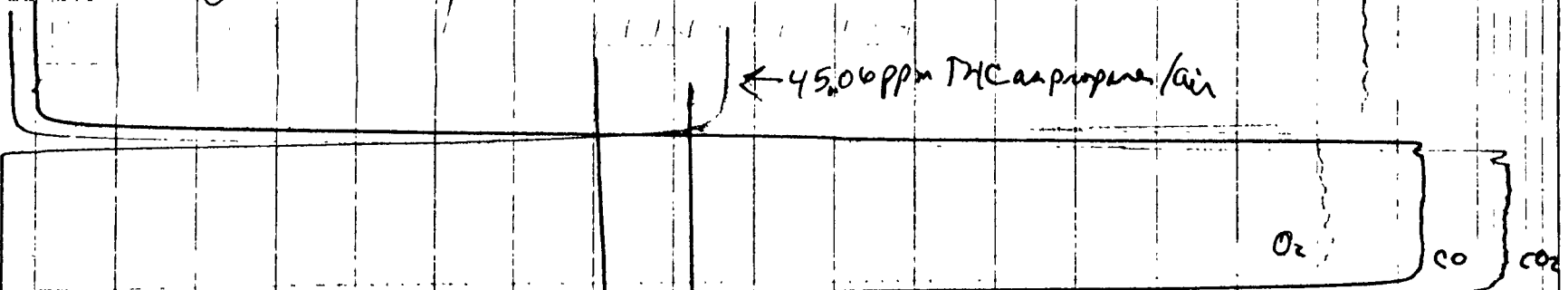
12/3/87 Test #2 Arsenic free waste  
BOAT Tulsa @ John Zink Co

Greene Thermo Wdette Ar 15%  
Red = B865 CO 500 ppm  
Blue = B865 CO2 20%  
Brown = B400 THC 100 ppm  
Black = TCPLP 1 up to 2500°F kiln  
Purple = TCPLP 2 up to 2500°F 2nd  
Chamber

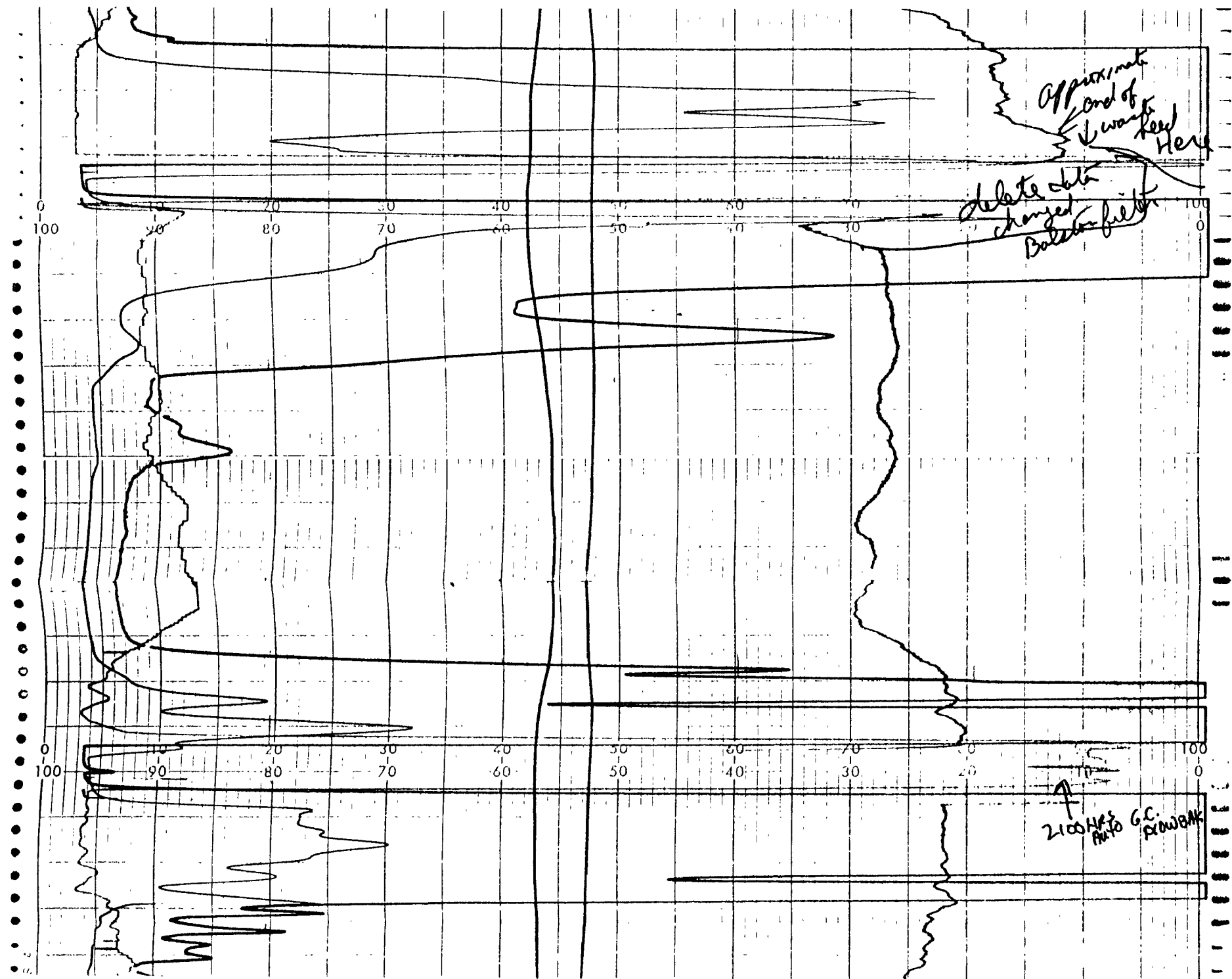
0 10 20 30 40 50 60 70 80 90 100  
100 90 80 70 60 50 40 30 20 0

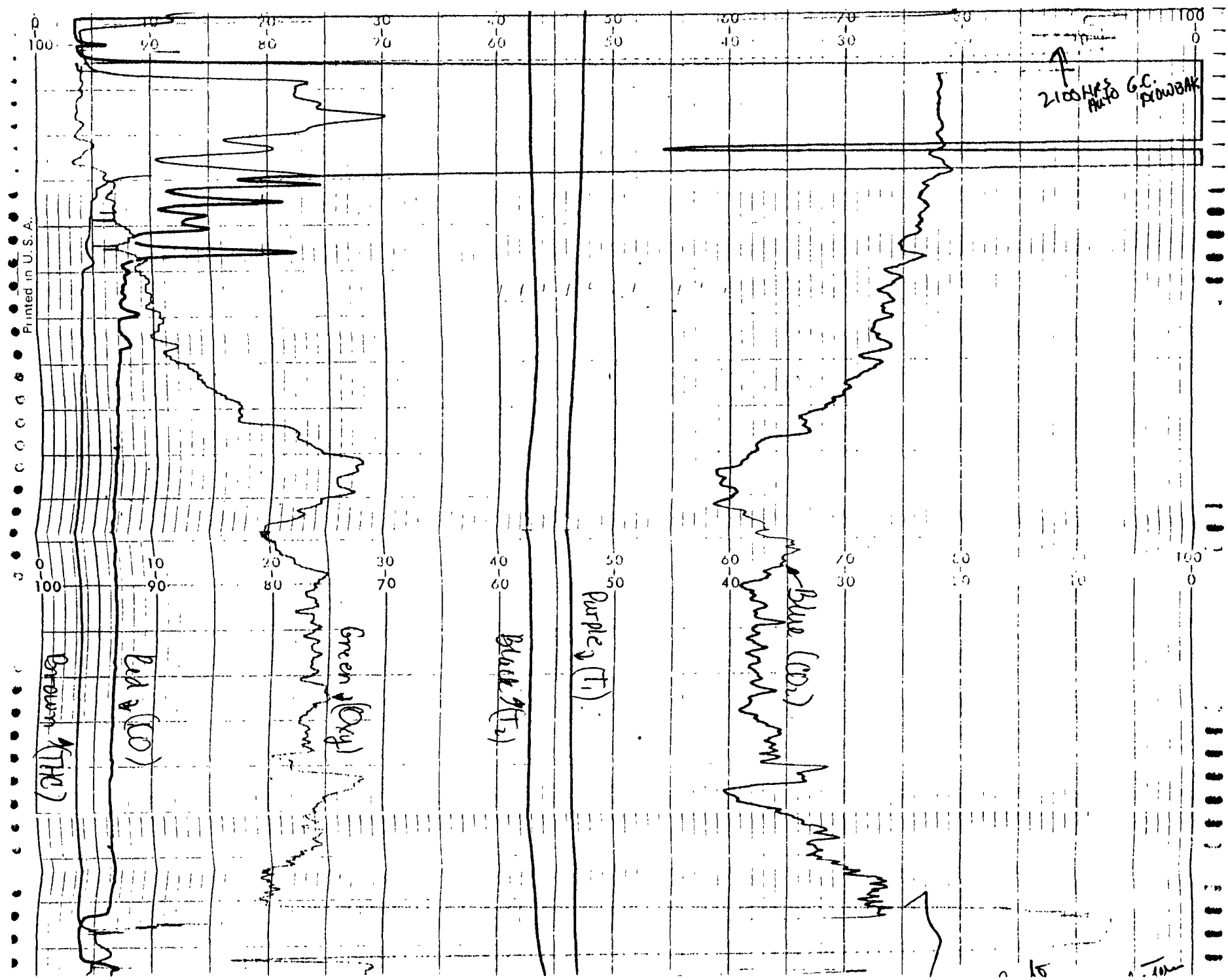
end BOAT/Tulsa 12/1/87 @ 2228 HRS

← 45.06 ppm THC as propane / air

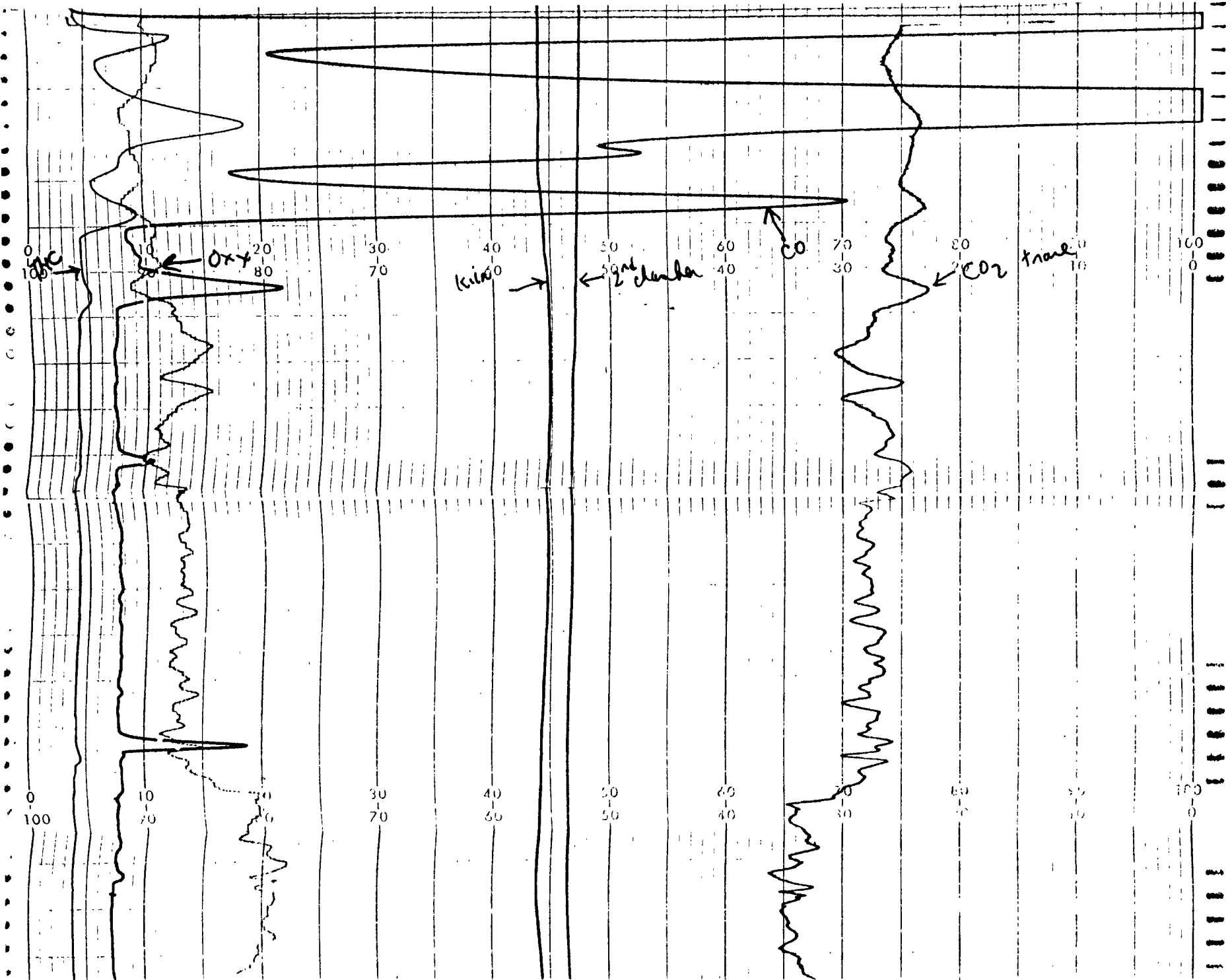






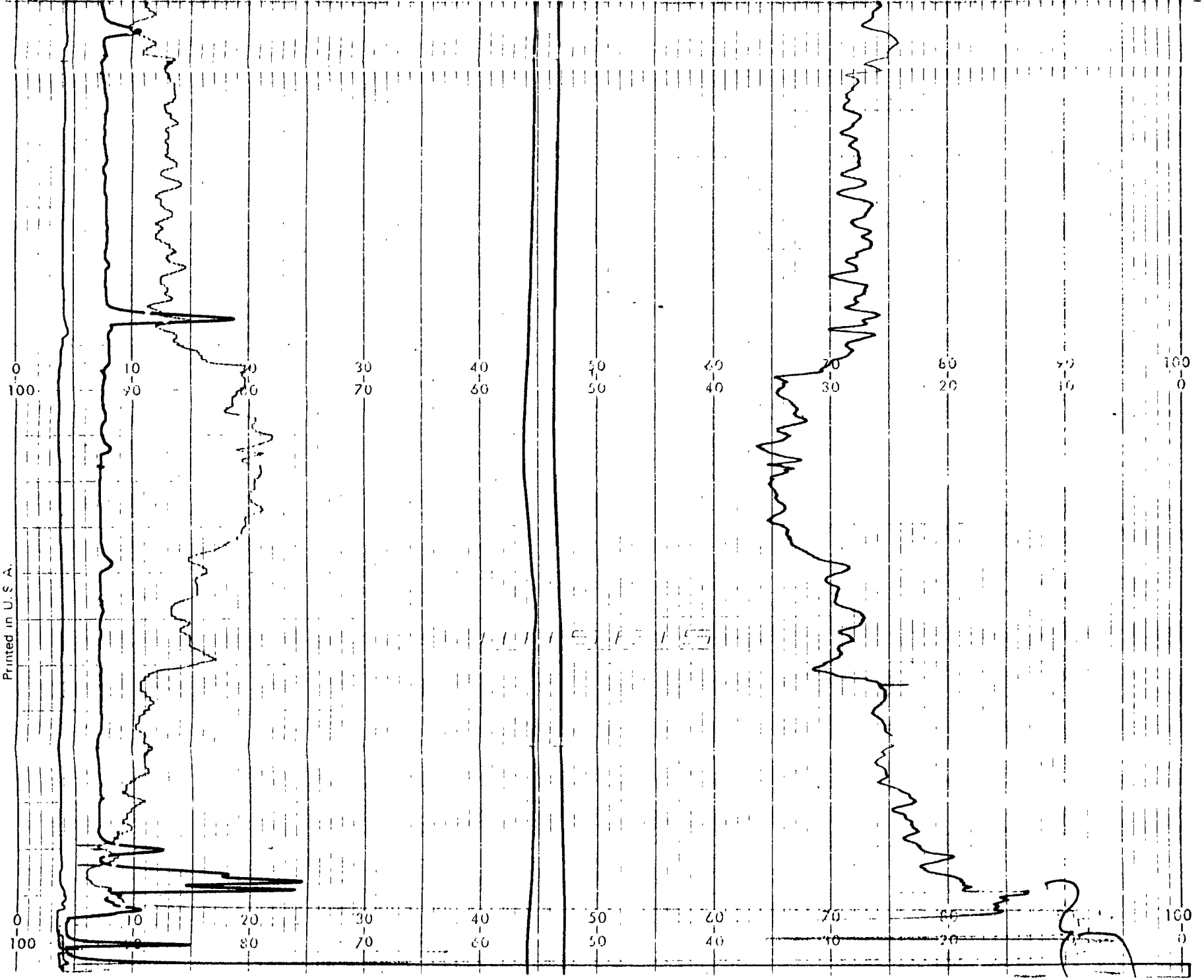


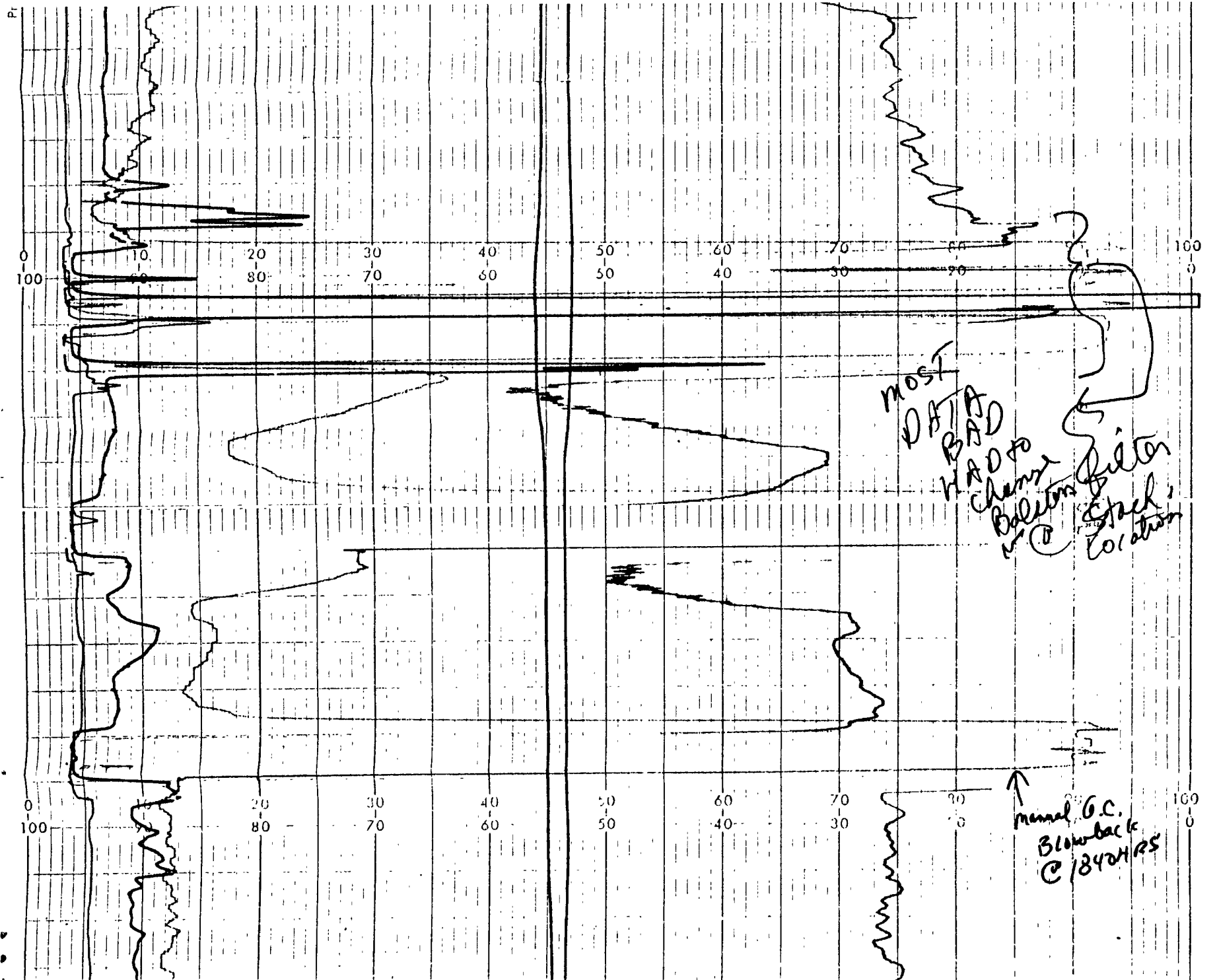






Printed in U.S.A.

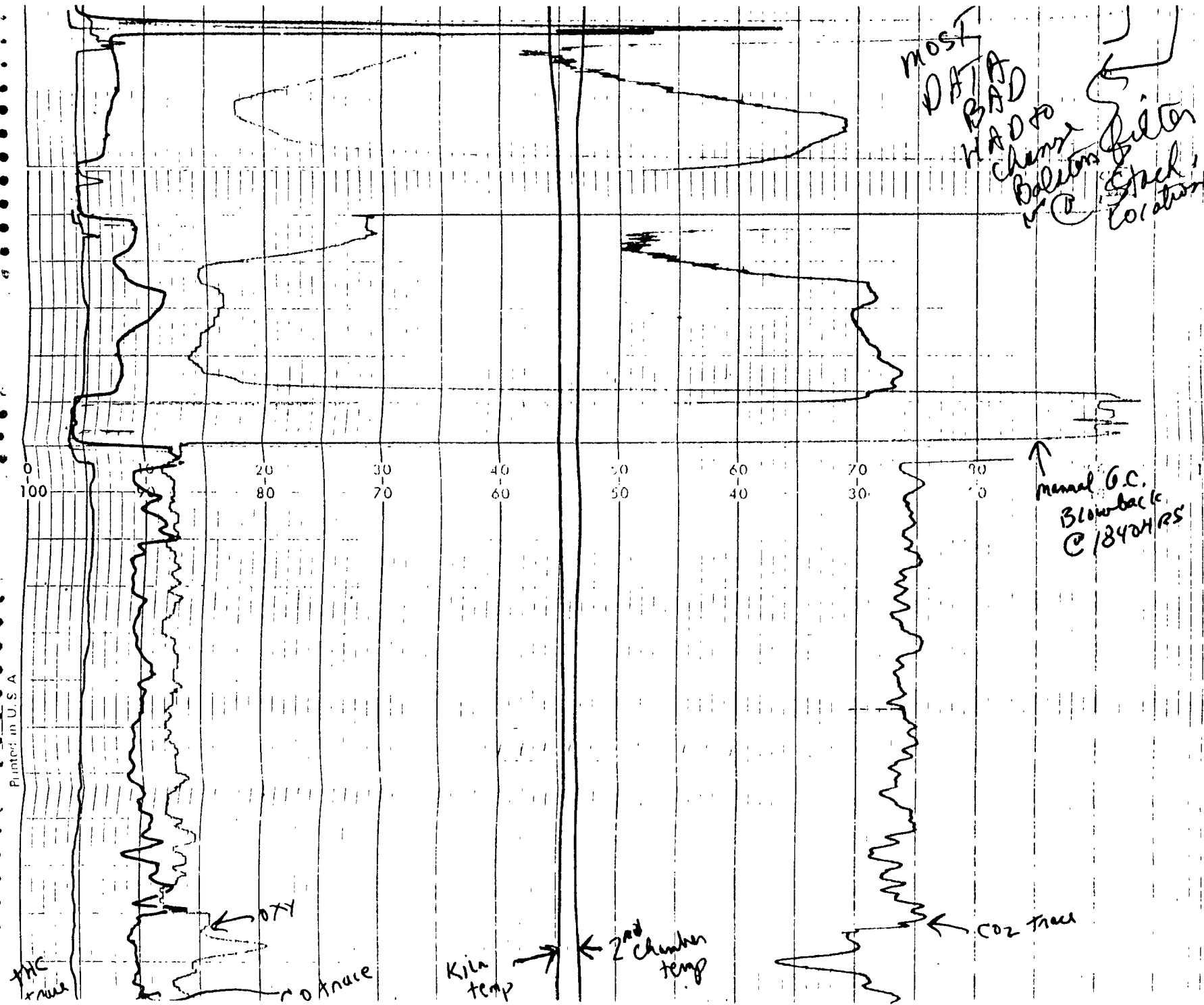




most  
DATA  
BAD  
HAD TO  
CHANGE  
Bullet  
M.C.  
Pilot  
Stack  
Location

↑  
manual G.C.  
Blowback  
© 18424 RS

Printed in U.S.A.



most  
DATA  
BAD  
HAD to  
change  
Balloon filter  
each  
location

normal G.C.  
Blowback  
@ 18424 RS

THE  
trace

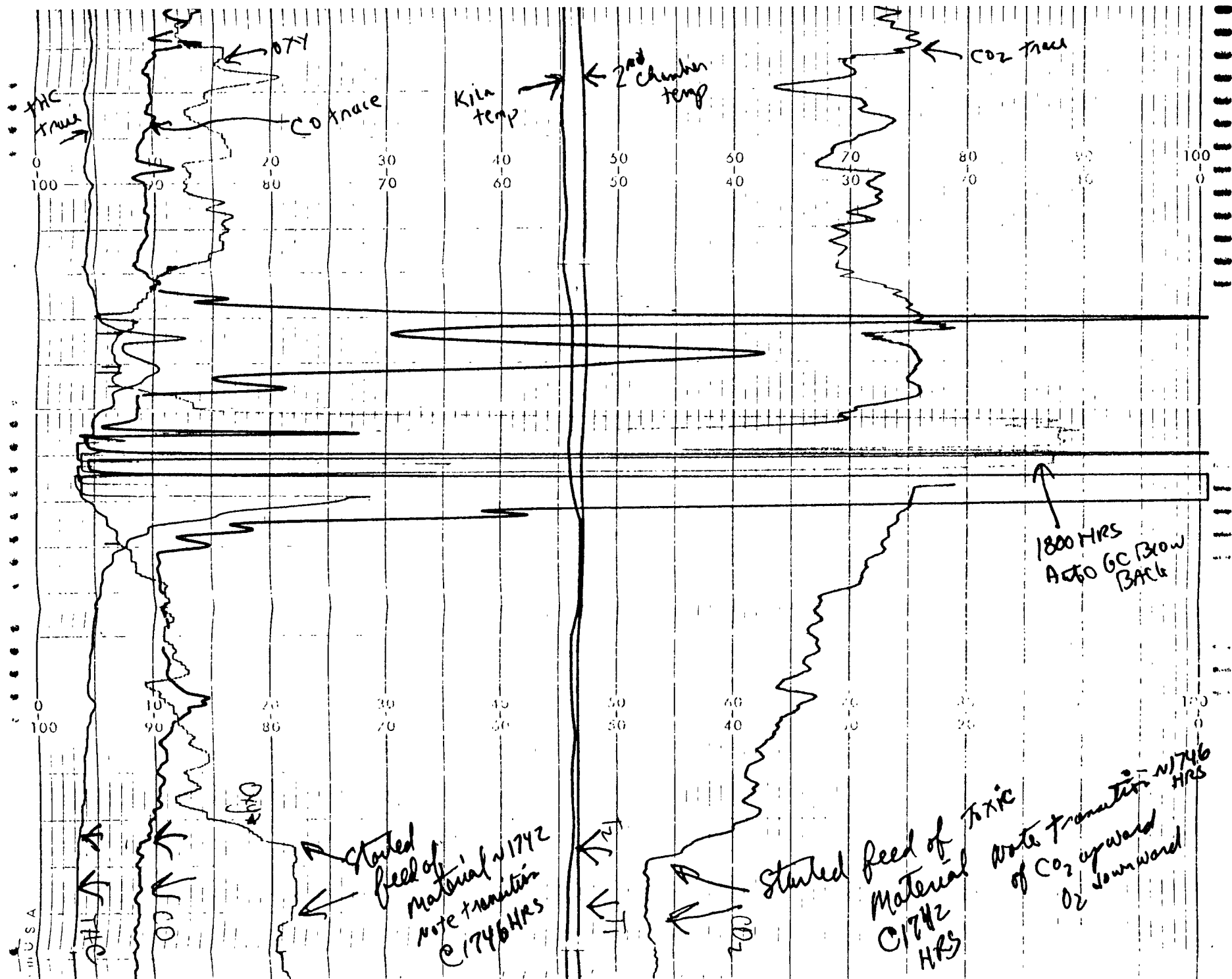
O<sub>2</sub>

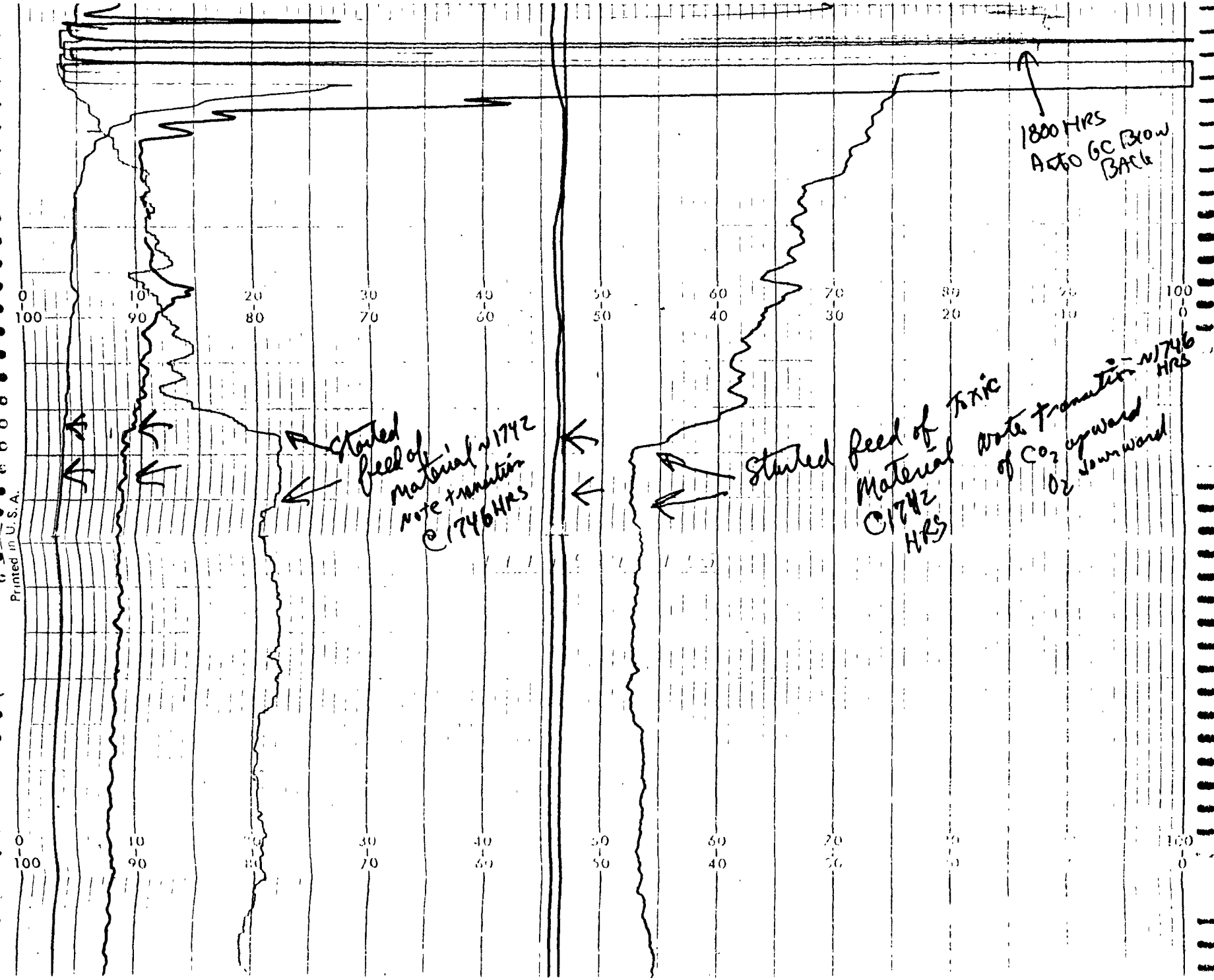
no trace

Kila  
temp

2nd  
chamber  
temp

CO<sub>2</sub> trace





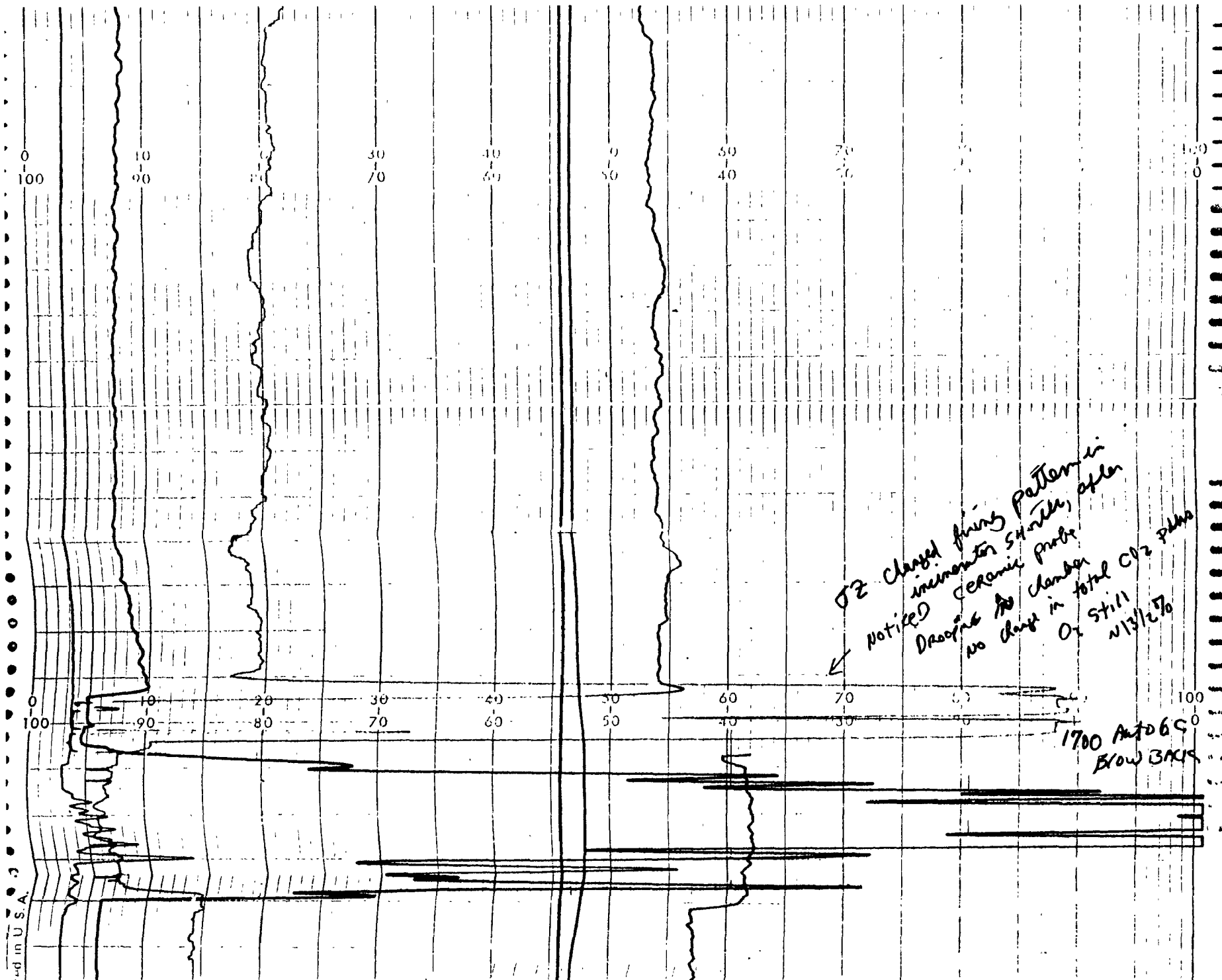
Started feed of material ~1742  
note transition @ 1746 HRS

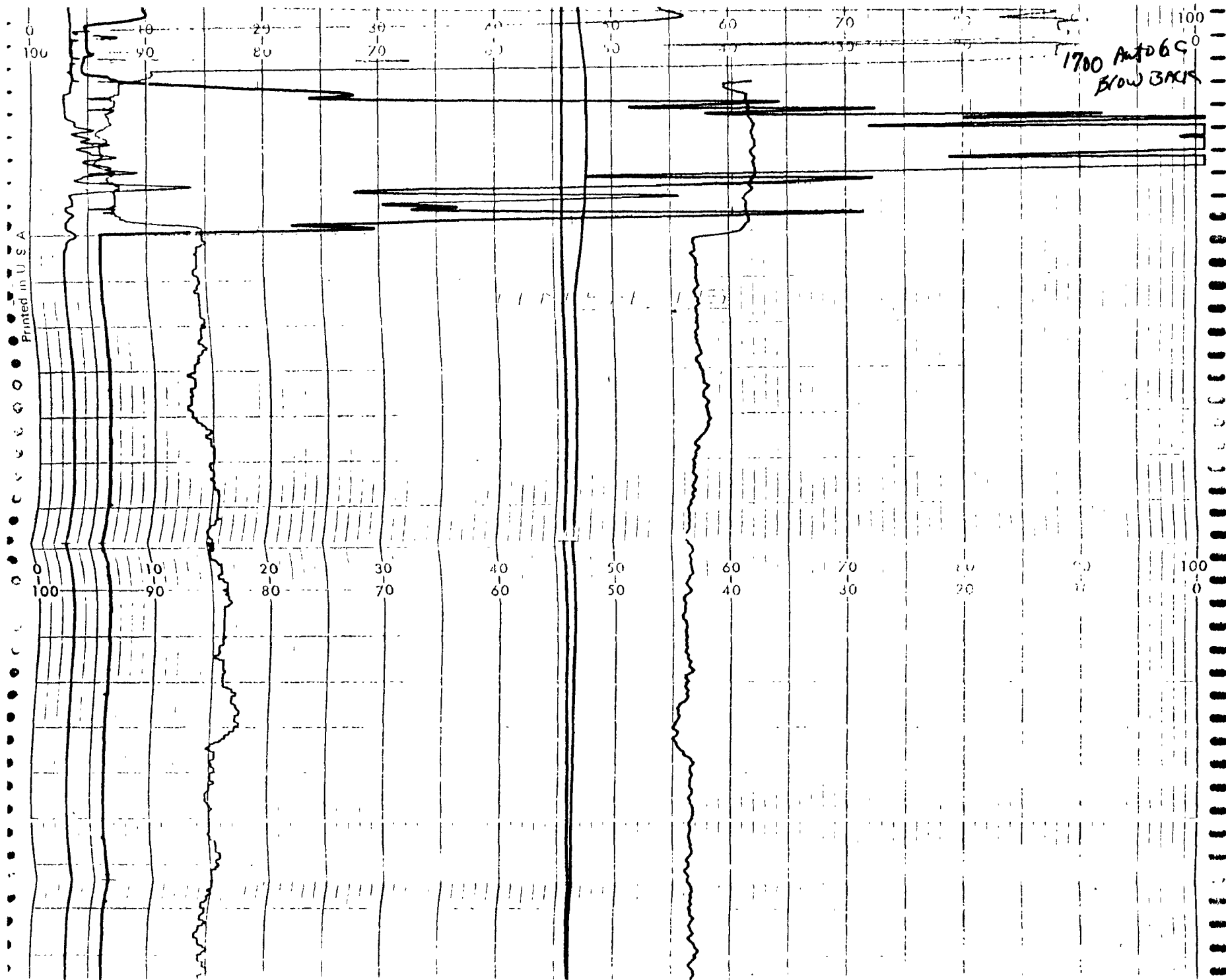
Started feed of material @ 1742 HRS

note transition ~1746 HRS  
of CO<sub>2</sub> upward or downward

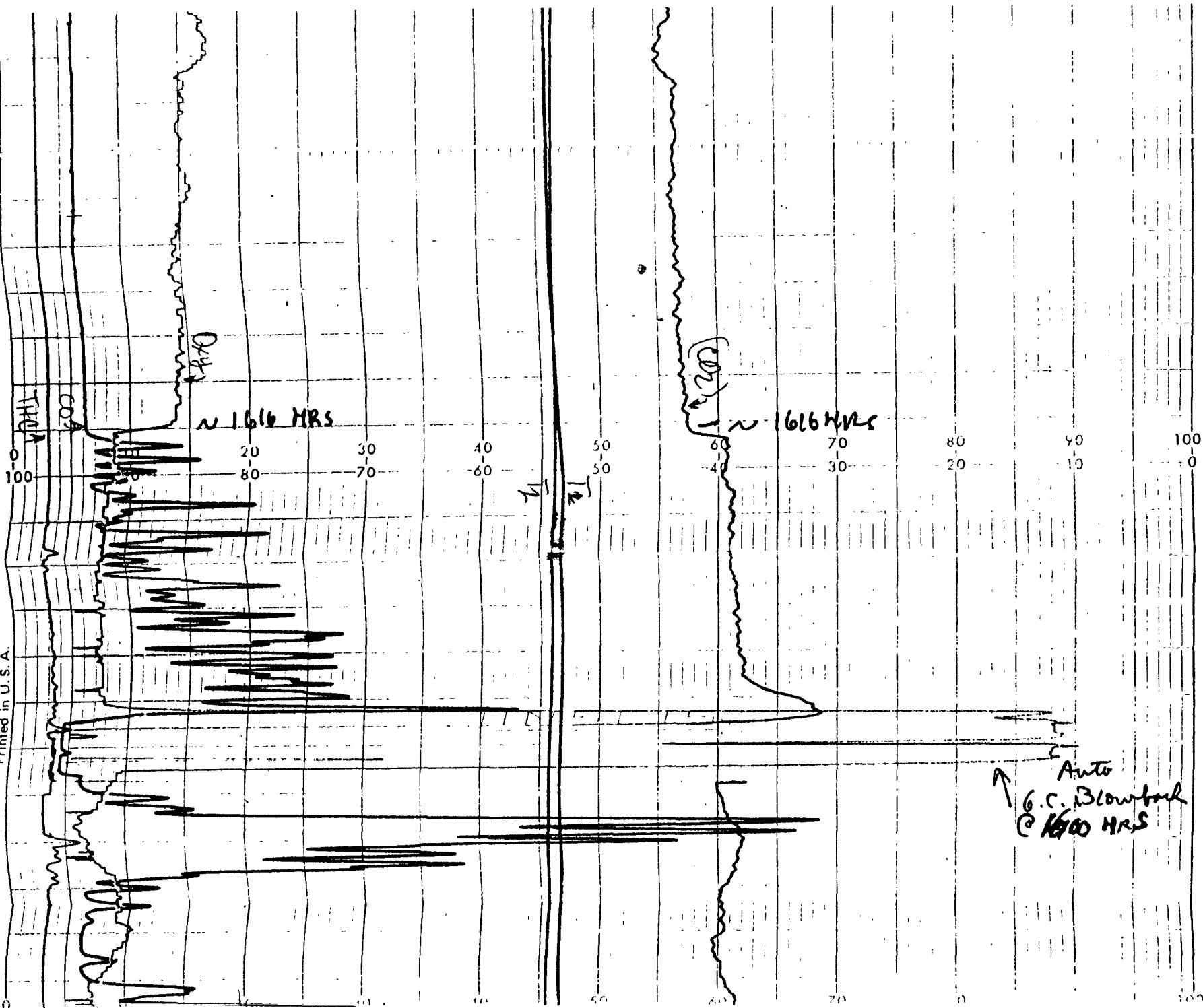
1800 HRS  
Auto GC Blow Back

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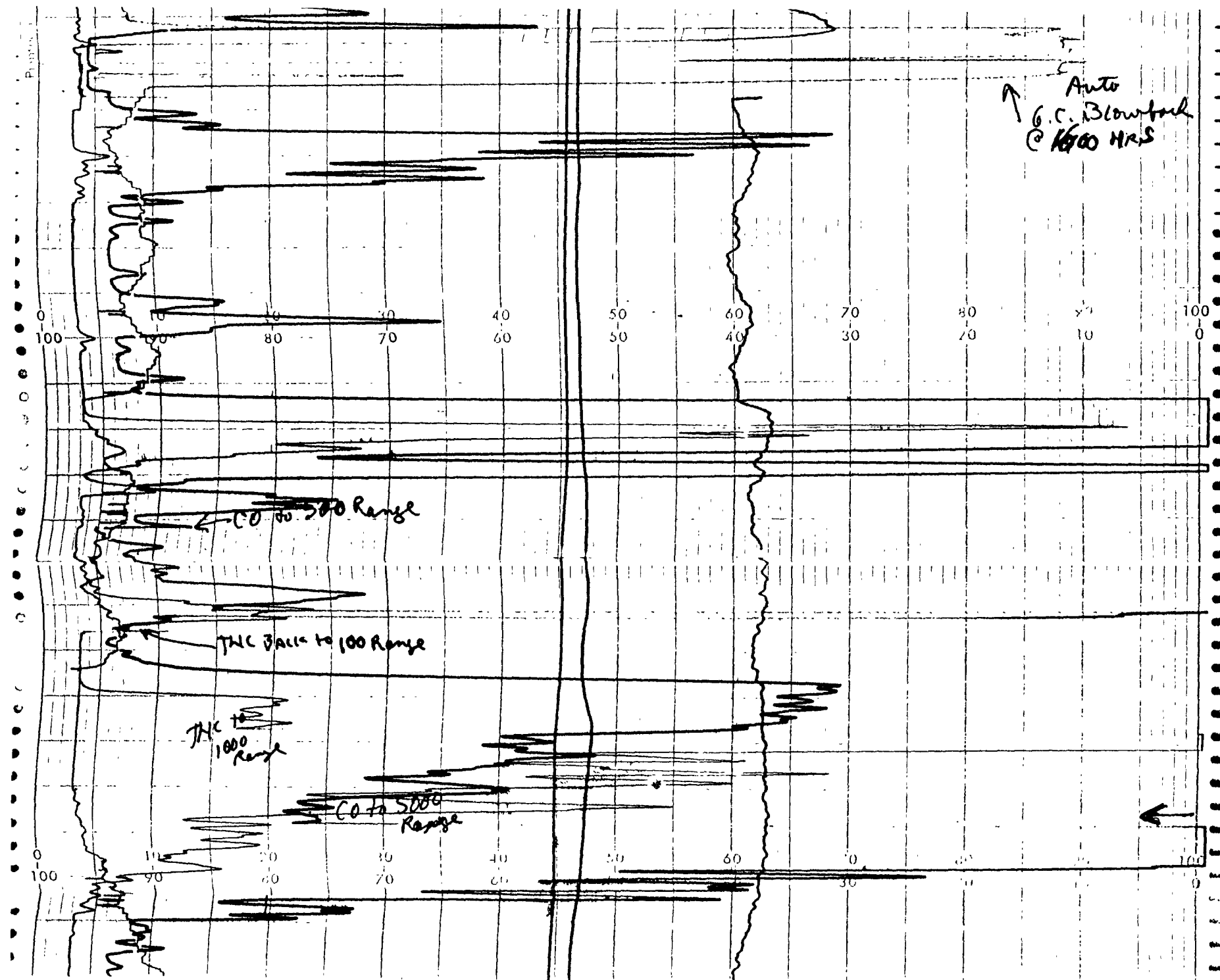


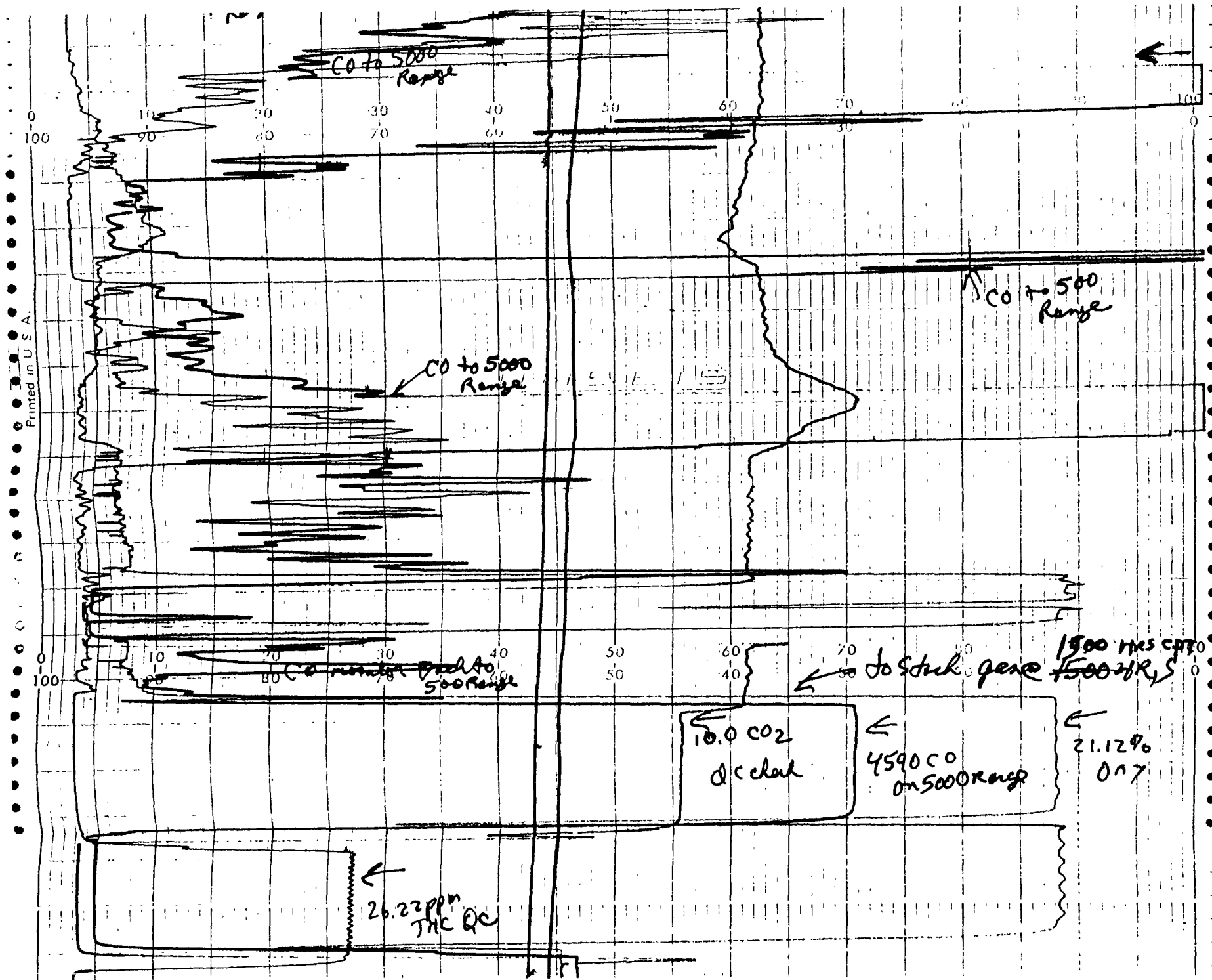


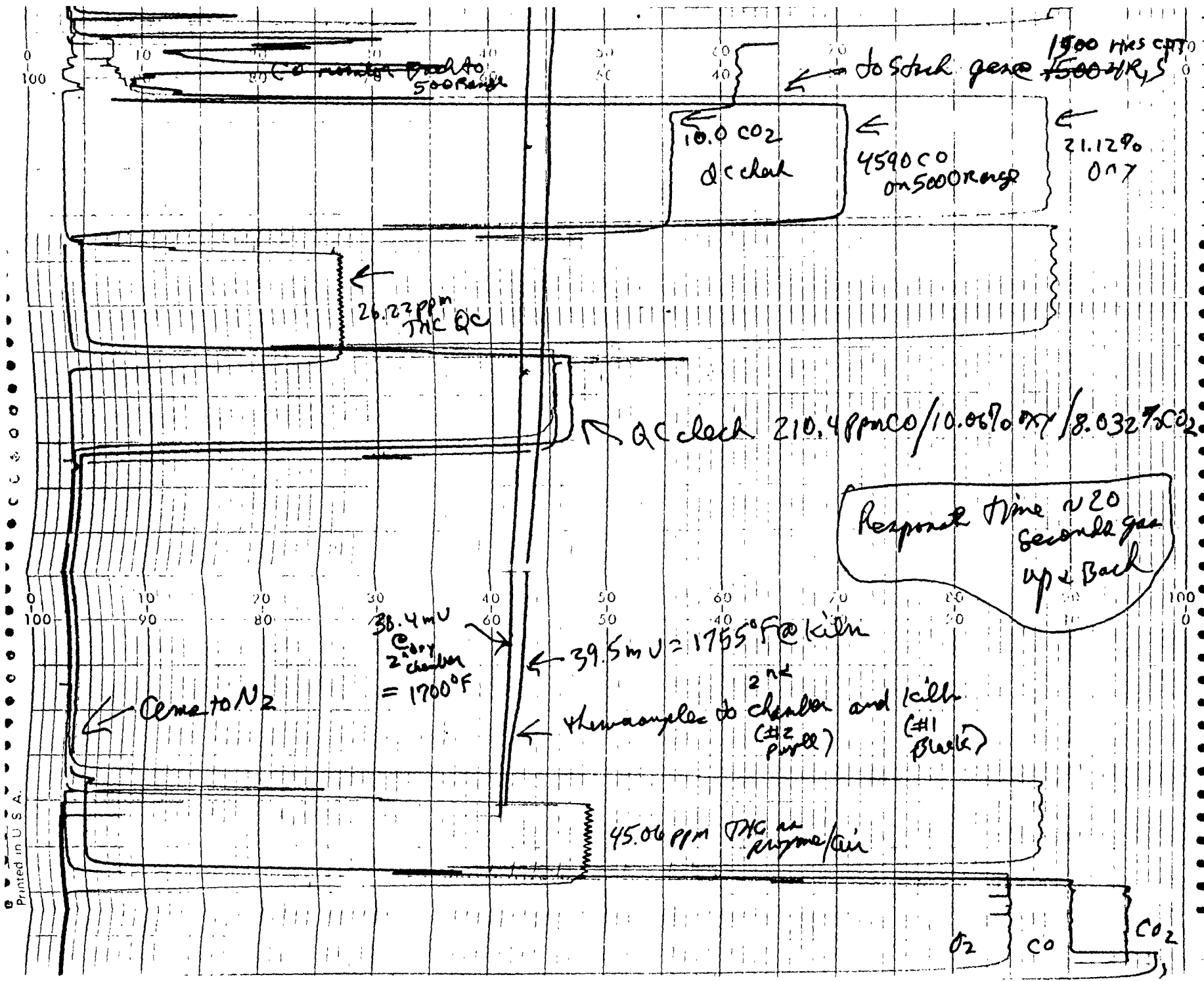
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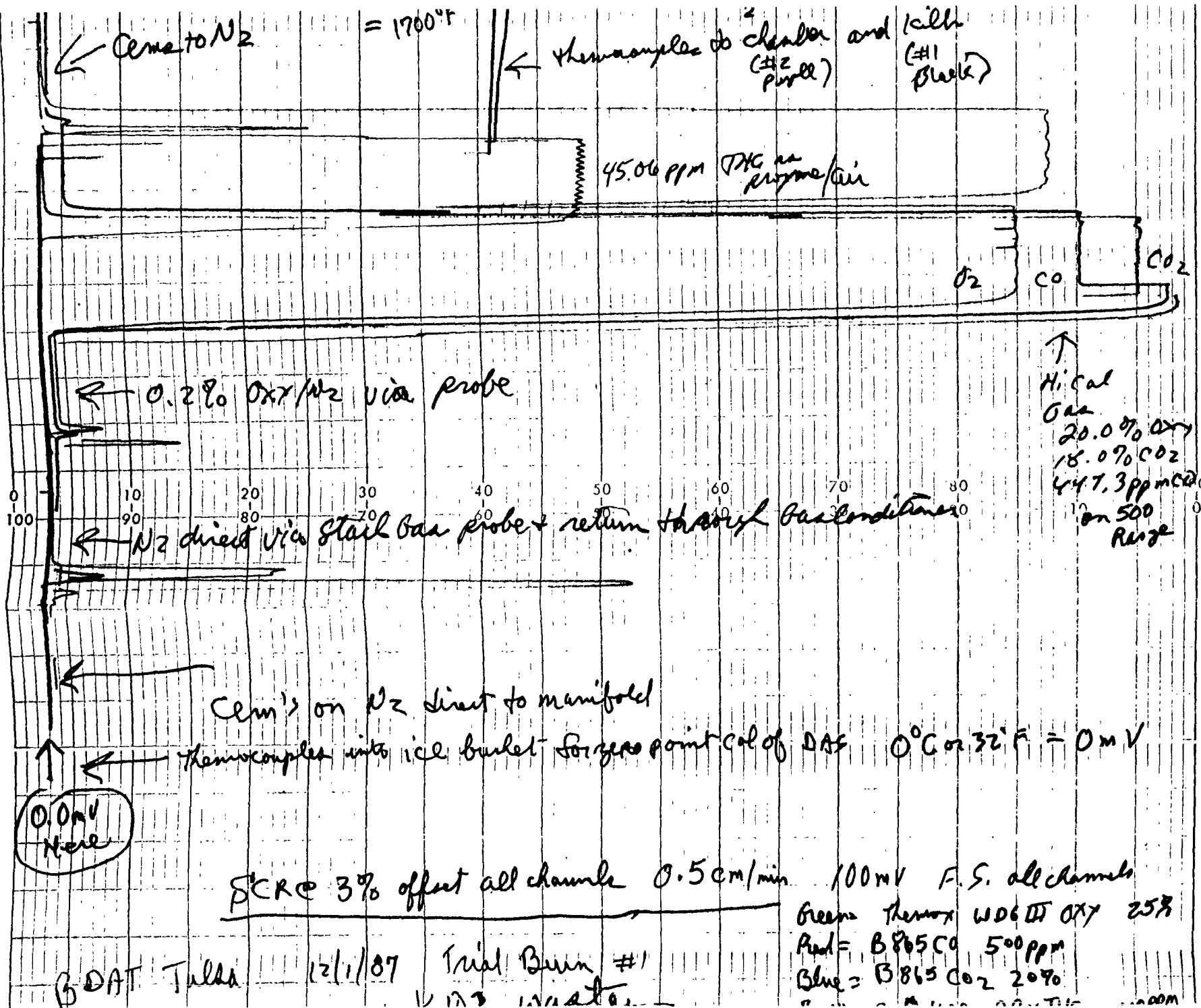








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←  
 ↑ ← Cem's on Pz direct to manifold  
 Thermocouples into ice bucket for zero point cal of DAS 0°C or 32°F = 0mV

0.0mV Here

PRC @ 3% offset all channels 0.5cm/min 100mV F.S. all channels

BOAT Tulsa 12/1/87 Trial Burn #1  
 K/DZ waste

Green = Thermox WDGDS OXY 25%  
 Red = B865 CO 500ppm  
 Blue = B865 CO2 20%  
 Brown = B400 OXYTHC 100ppm

0 100 40 90 20 80 30 70 60 50 40 30 20 10 0  
 BLACK pen = Thermocouple #1 HEARTH Purple = Thermocouple #2 AFT BURNER

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